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Engineering News-Record

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A MOMENT WITH THE PUBLISHERS

A Task for JOINT EFFORT

TWO recent public utterances illuminate from opposing viewpoints a problem that is of vital concern to the construction industry.

One, by Mayor La Guardia of New York City, records his opinion that within the next twenty years we shall find housing accepted as a normal function of government. Mayor La Guardia believes that this is inevitable because housing plays so important a part in public health that it must become a responsibility of government rather than of private enterprise.

The other speaker is Lewis H. Brown, president of the Johns-Manville Corporation, addressing the New York State Bankers Association. Like Mayor La Guardia, Mr. Brown feels that our system of home ownership leaves much to be desired and that all those who have an interest in the field should be taking thought concerning it.

Unlike the Mayor, however, he does not take it for granted that housing must become a public function, although he does record his belief that unless financial institutions are able to meet new requirements in home mortgage financing, they must expect the development of other sources of funds. Already a large volume of the public credit is devoted to that purpose.

FROM time to time this writer has recorded his conviction that the solution of the home-building problem, despite its importance to the construction industry, cannot be worked out wholly within the industry itself. As was so well pointed out last fall by Rolland Hamilton, president of the American Radiator Company, the key to this problem must be sought in the field of finance rather than in that of construction technology or management.

Mr. Brown apparently concurs in this judgment. He reminds us that the stability of this country will be increased by sound home ownership, and that both good business judgment and good citizenship demand that we approach the problem "from the broader social standpoint as well as from the standpoint of sound finance." He might have gone farther. The fact is that finance actually can be sound only so long as it is solidly established on that "broader social standpoint" for which he pleads.

Whatever temporary advantage may seem to inure to finance from any socially inadequate policy or measure, there can be no health or stability even for finance unless it applies its vast and vital functions to the conservation of the social welfare more effectively than it has done hitherto. Mr. Brown is on sound ground when he urges his banker hosts to help lift home-building out of the speculative mire and establish it on the rock of long term investment and stable proprietorship.

It is interesting to group for simultaneous consideration the opinion of Mayor La Guardia that housing is bound within two decades to become a public function, the judgment of Mr. Hamilton that the essential problem of home-building is one of finance, the conviction of Mr. Brown that we must approach the problem of home ownership from the social as well as the financial viewpoint and the recent warning of James P. Warburg that unless finance develops a more professional attitude with a keener sense of trusteeship for the public welfare, banking will pass from the hands of private enterprise into those of government.

HERE we box the compass of viewpoint: a public official with ultra-progressive leanings, a banker who sees his calling as something more than a profit-making device and two industrialists whose experience and interest encompass the complete problem from investor via the construction industry to the home owner. Through the complete cycle runs a striking agreement as to the basic need.

Mr. Brown's hosts can go far to help realize his hope that we shall be able to "provide more and more value in the home for less and less cost to the home owner and to do this with greater safety to the home owner and to the investor whose savings make possible the loan."

Here indeed is a call for cooperation between the construction industry and the financial institutions; to initiate and forward such an effort is just as much a responsibility of the construction industry as it is of the bankers.

Willard Chevalier

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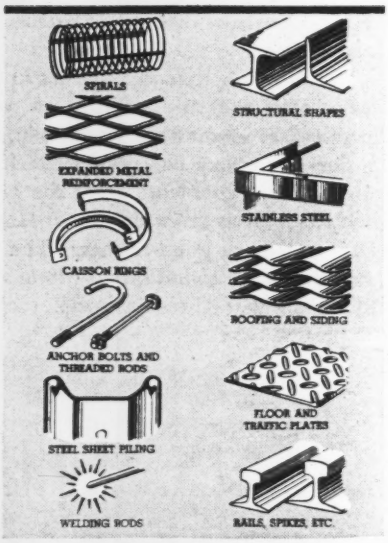

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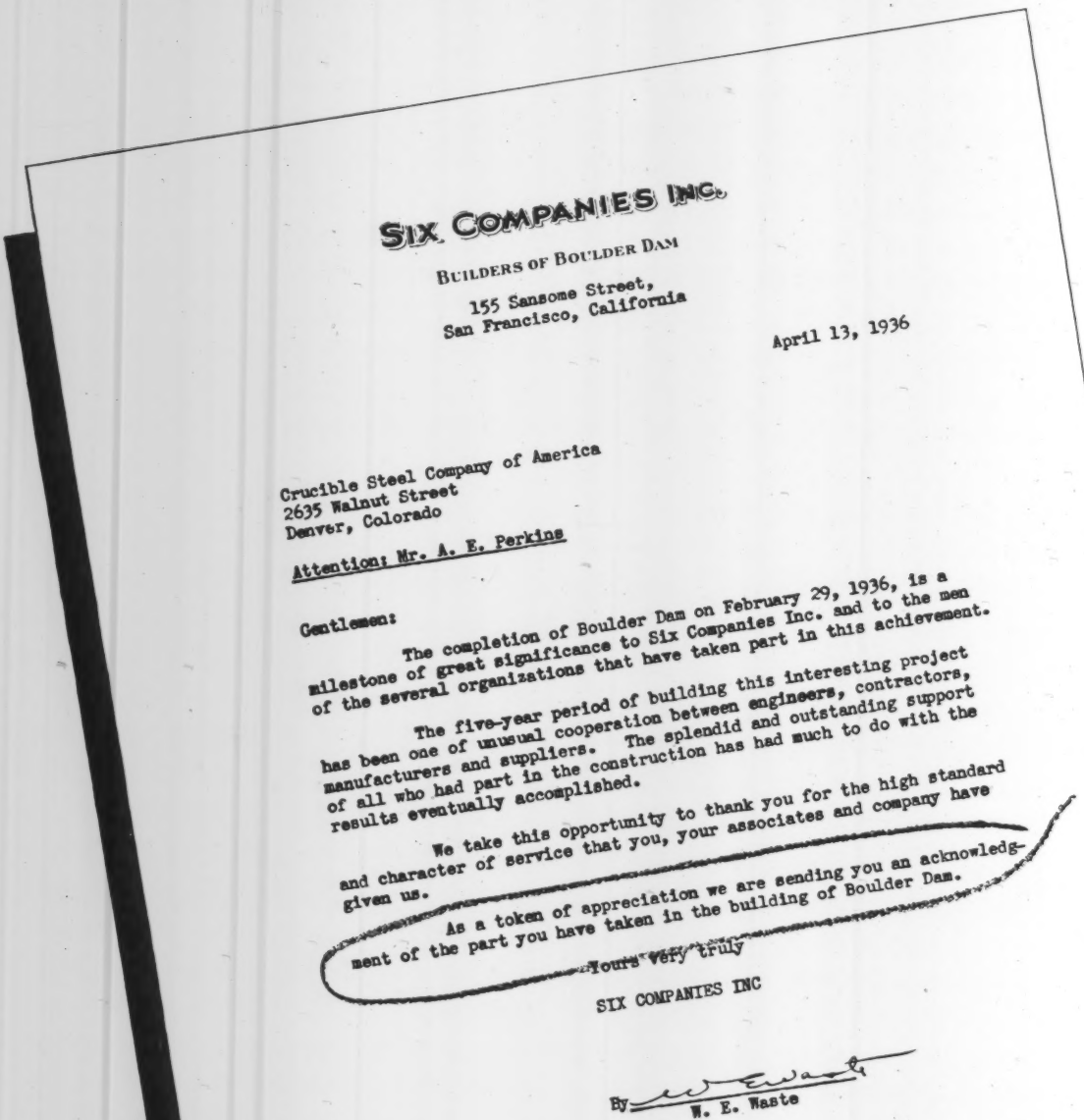

SIX COMPANIES INC.

BUILDERS OF BOULDER DAM

155 Sansome Street,
San Francisco, California

April 13, 1936

Crucible Steel Company of America
2635 Walnut Street
Denver, Colorado

Attention: Mr. A. E. Perkins

Gentlemen:

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The five-year period of building this interesting project has been one of unusual cooperation between engineers, contractors, manufacturers and suppliers. The splendid and outstanding support of all who had part in the construction has had much to do with the results eventually accomplished.

We take this opportunity to thank you for the high standard and character of service that you, your associates and company have given us.

As a token of appreciation we are sending you an acknowledgment of the part you have taken in the building of Boulder Dam.

Yours very truly

SIX COMPANIES INC

By W. E. Waste

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B - Z - Z - Z - Z - z-z—With this ominous sound the ubiquitous mosquito is once again making its perennial invasion, bringing disease and discomfort and leading millions of people to exclaim. "Can't somebody do something about it?"

● The "somebody" is the engineer; the "something" is outlined in a series of articles on mosquito control engineering beginning in next week's issue.

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ENGINEERING NEWS-RECORD

July 16, 1936

BIG DALTON DAM, one of California's notable buttress type dams.

Nine Hundred Dams Inspected

Six-year California investigation shows one-third of all the dams need repair. . . . Major defects in foundations, inadequate spillways, or in materials or construction

By George W. Hawley
Deputy State Engineer in Charge of Dams
Sacramento, Calif.

SPILLWAYS of inadequate size, too much left to chance in materials and construction methods, lack of proper emphasis on geological studies of foundations—these are typical of the most common faults in the 950 California dams examined in recent years by state authorities. For the purpose of safeguarding life and property, the California State Legislature of 1929 enacted legislation (held to be "constitutional in all its essential provisions as not only a proper, but a necessary exercise of the police powers of the state") making it mandatory upon the state engineer to exercise supervision over all dams in the state, other than those federally owned, whether already built or to be built, which are 25 ft. or more in height or which store 50 acre-ft. or more of water.

The act, which was passed after the catastrophal failure of the St. Francis dam of the Los Angeles Water Supply System, provides for (1) inspection of existing dams; (2) approval of plans and specifications for and inspection of construction of new dams or the enlargement, alteration, repair or removal of existing dams; (3) supervision over maintenance and operation of all dams in so far as necessary to safeguard life and property.

Under the act a three-year period was allowed for examination of the then existing dams, and thereafter the state engineer was required either to issue (1) a certificate of approval that the dam was safe or (2) an order requiring the owner, within a specified time, to make such changes in his dam (specified in each case) as were found necessary to render the dam safe. The total number of dams built prior to the effective date of the act (Aug. 14, 1929) which were examined critically by the department is 830. On these structures the state has reviewed and passed upon 422 applications and sets of plans for repairs and has exercised supervision over safety features of the repair work. Altogether the total number of dams passed upon is 950.

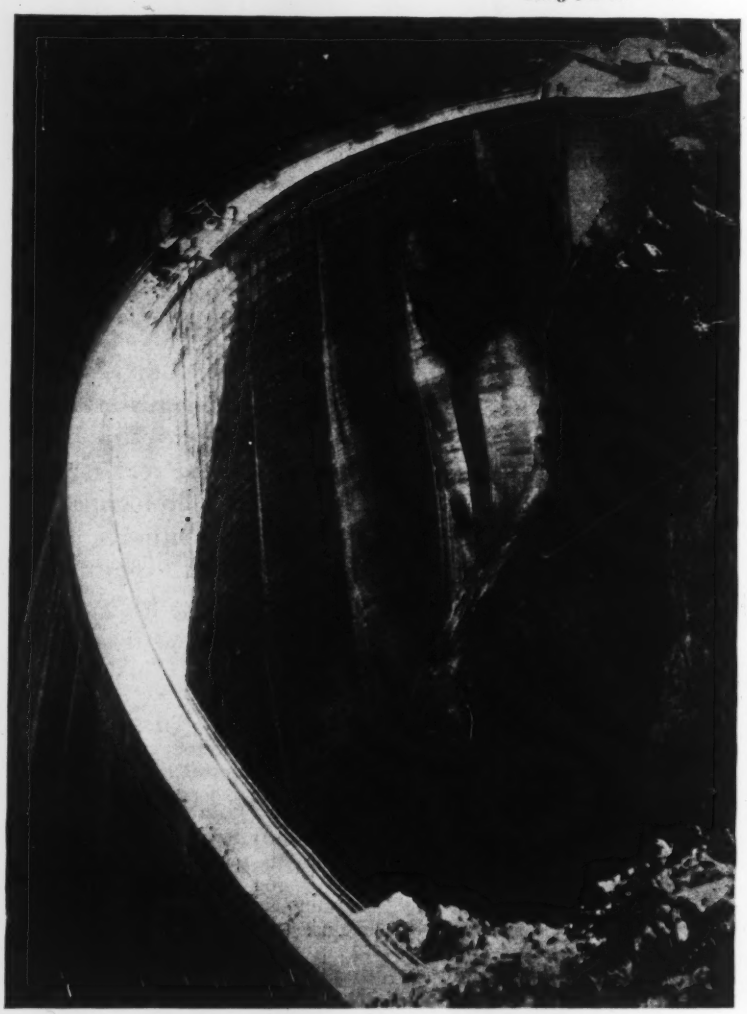
The requirements of the law in the matter of applications for permits for construction of new dams place upon the state engineer responsibility for reviewing plans and specifications, examining proposed sites and supervising construction in so far as safety is concerned. During the period from Aug. 14, 1929, to Jan. 1, 1936, the department has reviewed plans, specifications and sites and supervised as to safety the construction of 110 dams, which cost $60,000,000 and added to the state's water storage 1,000,000 acre-ft. During this same period there have been 30 enlargements of existing structures under state supervision costing approximately

O'SHAUGHNESSY DAM, a gravity type concrete structure built with provision for raising it to a height of 430 ft., work that now is in progress.

poses, elevations from sea level to 10,000 ft. Some are in arid areas while others are in basins subject to rainfall of cloudburst intensity or to heavy spring runoff from suddenly melting snow. The dams vary widely in height; many are outstanding structures of their respective types. Some are constructed at sites where the geology is of major import—as across earthquake faults.

Because of the large number of dams in which a complete review of design would be necessary, a compendium was prepared outlining principles and fundamentals to be applied in analyzing stresses, problems of design, and the many complex hydrographic and hydraulic problems involved. This saved much duplication of work. Various theories of analysis were compared, to aid in selecting methods applicable to the wide variety of problems. While this office work was going on a comprehensive program of field work was undertaken to "review" all old dams and

PACOIMA CREEK DAM, one of the high arch dams of California, its total height being 380 ft.



$4,600,000 and making available approximately 200,000 acre-ft. of increased storage.

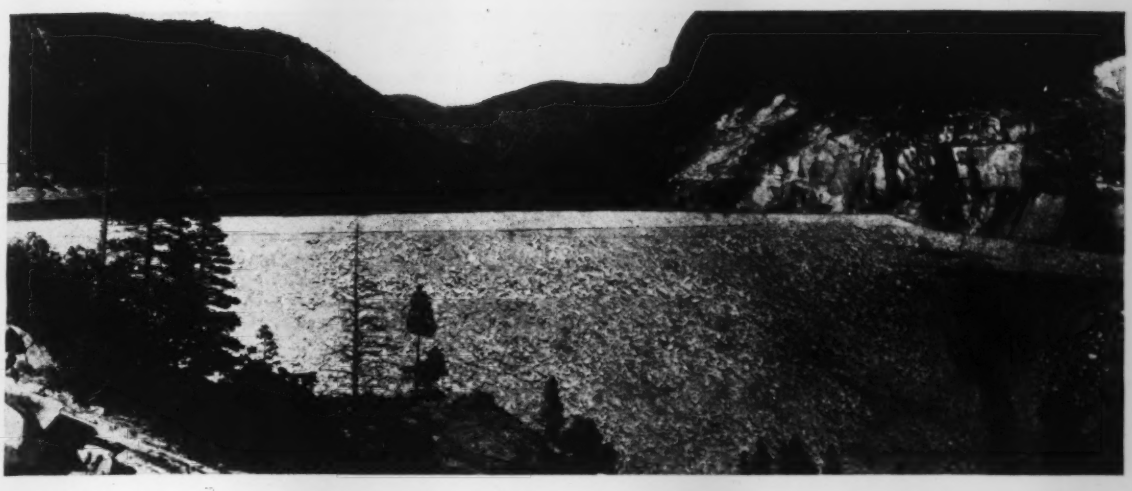
Dams now under state jurisdiction total 588, representing a storage capacity of 7,000,000 acre-ft. and a total capital investment of about $200,000,000. Table 1 gives the percentage of each in the several distinct types of structures. In Table 2 will be found the principal characteristics of some of the major structures of each type.

Now that the studies as a whole have been completed and the work of the department has been well developed on the basis of extensive experience in reviewing dams, a summary in the form of notes and comment on the work thus far may be of benefit to those who may have similar problems. Such a summary is given in the following.

Program of examination

To carry out the law in the matter of reviewing existing structures, approving new construction and supervising the maintenance and operation of dams, a new division of the state engineering department was created and placed under the supervision of the state engineer. Because of the volume, importance, responsibility, and highly specialized nature of the work involved, the personnel of the division was carefully selected on the basis of technical ability, experience, and other qualifications for passing on the safety of dams. The organization has been adapted to the changing requirements of the work; there was a rush, of course, in the early stages when the large list of existing structures was awaiting attention.

The structures examined include numerous types, a wide variety of pur-



SALT SPRINGS DAM holds the record for height in rock-fill dams, 325 ft.

to learn as much as possible from observing them under full load as well as with reservoir drawn down. This was part of the program for bringing to the office staff all information available from engineering and geological studies in the field.

Eight or nine capable engineers and an engineering geologist headed the field work in different areas. Each field man made thorough inspections of each dam within his district, checking the accuracy of the dimensional data furnished by the owner and securing all additional information necessary or possible from any and all sources. Data so gathered were sometimes topographical and sometimes structural. Where necessary the geologist made field and office studies and submitted his reports relative to the strength and condition of the foundation and abutment formations and of the materials of construction. These examinations developed much information pertinent to the more exact analyses that were later made in the office. The office studies, therefore, always were based on actual data (so far as could be determined) rather than on theoretical dimensions and conditions recorded in reports or obtained from other unchecked sources of information. These studies embrace a stress analysis of the structure itself (or, if not homogeneous, of its structural members), hydrographic investigations dealing with estimated maximum runoff, and hydraulic consideration of spillway capacity, overpour depth, etc. The results of these studies were given to the field man for guidance in future inspections.

In other words, the field man was instructed where to look for evidences of stress and what points were likely to show weakness. Frequently the field man was accompanied by one or more assistants, by a superior officer or by an engineer representing the owner. With the latter were discussed possible modifications of undesirable features, and in this way there was maintained a close contact between the state's organization and the owners of dams. These contacts were invaluable in avoiding delays and disagreements in administering the law.

Often it was necessary to consider numerous theories and novel ideas of individual engineers. Frequently these proposals came from widely different schools of thought, some of which rested on erroneous conceptions or sought to attain unreasonably low cost. The act specifically charges the state engineer with the safety of the structure and does not in any way consider costs. It was recognized, however, that if (in the interests of safety) unreasonable conditions were imposed upon the dam builder development would be prevented thereby and progress in the evolution of new designs halted.

The personnel of the department, together with consultants, when necessary, has aggressively and intensively initiated and advanced such studies, investigations, and examinations as have been necessary to competent passing upon the safety features of each dam under jurisdiction and its appurtenant structures.

The 830 old dams reviewed by the state fell into three general classes, each embracing roughly one-third the total number of dams. One class comprises the structures that could be approved immediately as safe without further delay and without modifications. The second included the dams that required more thorough study before final decision could be made—that is, it was preferable to await opportunity to observe the dam under water load, or obtain information about foundations not available on surface inspection, or take seepage records over a period of years, etc. (3) The third class could be pronounced at once to need alterations or repairs, either major and some minor in extent.

In addition to the one-third on which alterations were required there was a large number of dams on which certain minor work was desirable though not of vital importance. Items contributing to this classification were: better flashboard arrangement, increased length of spillway lining, rehabilitated intake structures, apron extensions, control valves on the upstream end as well as the outlet end of conduits through the dam, etc. By effecting these changes the safety of dams has been greatly increased even aside from the actual rehabilitation work required by state authorities. Altogether, there has been great educational value in the study, and not a few owners have changed from a skeptical if not antagonistic attitude to a wholly cooperative point of view.

TABLE 1—DAMS NOW UNDER STATE SUPERVISION CLASSIFIED AS TO TYPES

Type	No.	Per Cent of Total*
Embankment Type		
Earthfill; compacted, hydraulic or semi-hydraulic	379	64.5
Rockfill	39	6.6
Concrete or Masonry		
Gravity	50	8.5
Arch: variable radius	25	4.3
constant radius	34	5.8
Buttress: Multiple arch	15	2.5
slab	19	3.2
Timber and Miscellaneous	27	4.6
Total	588	

*These percentages differ very little from those applying to a classification of all dams examined.

Spillways Deficiencies Common

A majority of dams on which rehabilitation work was required had spillway deficiencies, either structural or hydraulic. In this respect, as in many others, every dam has so many individual characteristics that it must have individual consideration. There is no general rule that will apply to all dams of a given height, type and reservoir capacity, and this applies quite as

much to spillways as to other features of the dam. The type of spillway, the amount of surcharge detention (storage capacity above spillway elevation), the characteristics of estimated flood flows, the character of the structure itself and of its facing, require individual consideration.

Precipitation intensity varies widely in California: some areas are practically rainless and others have annual rainfalls as high as 60 in. Intensities of rainfall in some areas approach a cloudburst condition. For example, since the study began a 45-sq.mi. area in which rainfall usually is relatively low has experienced a runoff as high as 500 sec.-ft. per square mile.

In studying spillways, only considerations that affect safety could be used as a basis for requiring rehabilitation. Many different types of spillways were encountered, including weirs, channels with lateral and with side flow, shafts, tunnels and siphons.

Safety conditions

Generally speaking there are three chief elements to be considered in studying the safety of a spillway: (1) hydraulic, (2) structural and (3) conditions involving residual freeboard. Hydraulic conditions involve capacity, turbulent flow, energy dissipation, curves in flow alignment, hydraulic jump, erosion from backwater or eddies, etc. Structural considerations include lining, paving, design of the walls for cantilever action, slope lining, cutoffs, the use of wing walls, and consideration of such other matters as undercutting, risk of bank saturation, etc. Residual freeboard may be defined as the vertical distance between the water surface when the spillway is discharging maximum flood flow and the crest of the dam. Rulings as to the necessary amount of residual freeboard call for judgment in selecting the level of maximum permissible water surface during peak floods. In the case of embankment dams the length of reservoir exposed to wind action may be a factor. There must be enough residual freeboard so that the maximum waves that are likely to occur will neither go over the dam or do damage to the upstream slope.

To bypass safely the maximum estimated flood flow at any particular reservoir there is choice of a wide variety of spillway types, so far as hydraulic functioning is concerned. The final selection then becomes a matter of economics rather than safety and is to a large extent dependent upon the topography of the site. For example, it is found in many instances that a wide shallow spillway will be more advantageous than a deep narrow one because, although both may have the same discharge capacity and the same residual freeboard, the former will have the advantage of developing greater storage without decrease in safety.

Among the large number of dams reviewed, those of the gravity type have in general required the least rehabilitation work and such as has been necessary was largely a matter of protection against erosion at abutments; this statement does not include work on spillways, which is common to all types of dams and has been discussed above. In the older concrete dams there is the inevitable evidence of lack of the modern knowledge and skill which produces superior concrete under present-day technique. Even so, it is notable that low structural strength from all causes combined (including poor materials and workmanship, inadequate design, absence of allowance for uplift, etc.) takes third place in importance among causes of major risks in gravity dams.

First on the list is deficient foundations, indicating lack of adequate geological advice in passing upon foundation materials and in selecting the most favorable location. There is ground for the claim that deficiency in this respect is only partly chargeable to the engineer; partly it results from the difficulty of finding capable geological talent tempered with practical engineering knowledge sufficient to put an engineering interpretation on geological indications.

Second in the list of typical risks to the gravity dam comes seepage and drainage. In the more modern dams this is taken care of by thorough grouting followed up by adequate provision of drain pipes and galleries to lead away such water as may come into or under the structure. The risk attending seepage is that, in the absence of adequate drainage there may be harmful foundation saturation, or leaching of the concrete, or dangerous pressures. In recent years the development of more effective grouting methods applied in the cutoff and around the abutments has reduced seepage to a relatively unimportant factor.

Arched concrete dams, of both constant and variable-radius type, constitute a considerable percentage of recent concrete construction. As confidence in these types has developed and as high dams at low cost have been in demand, conditions arise which naturally favor the thin arches. A common risk attending structures of this type is that engineers are wont to locate the dam on the basis of surface topography rather than suitable rock topography. The result is that by the time the abutments are fully excavated they are too far downstream. In addition there seems to be a reluctance to go into the supporting rock far enough to get adequate radial abutments, although this is a fundamental requirement for satisfactory construction of dams of this type. It is to be remembered that arch abutments will have unit loads equal to or greater than those under a gravity structure of corresponding height. The matter of abutments and foundation has required very careful scrutiny in recent dams in California because the really favorable sites have been developed long since and those coming up for consideration now frequently make use of sites that were rejected before for economic reasons.

In general, overpour should be avoided in arch dams, as the tendency to concentrate the flow into a restricted channel below the dam increases the risk of erosion and scour, and as there is risk, also, that vibration resulting from overpour may cause deterioration of the structure.

Buttress type

About 6 per cent of the dams reviewed were of the buttress type. Although several excellent dams of this type are in service now, some of the earlier ones have notably deficient structural features. The Lake Hodges Dam, near San Diego, and the Little Rock Dam, near Palmdale, have relatively thin buttresses, practically without reinforcing, and here typical buttress cracking is found. Rehabilitation work now under way on the Lake Hodges Dam consists largely of strengthening the buttresses.

The seismic factor is coming to be an element to be considered in the design of dams in a region subject to earthquakes and has been applied even to the gravity type. If it is logical to make allowance for seismic factor in such a structure, certainly it is more so to make some seismic allowance in the thin slabs and beams of the multiple-arch and slab-and-buttress dams. Where a seismic factor is included in the design the usual allowance is for a horizontal force in any direction of 0.1 g.

Embankment dams

The notably large number of embankment dams, (over 60 per cent of the total number of dams analyzed), indicates the effective way in which they fit into the requirements that obtain in California. Earth and rockfill types may be considered in the same category because they both require a stable section, an impervious element, some form of cutoff, separate spillways, and absolute protection against overtopping. As in the case of gravity dams, the most common defect, except for inadequate spillways, is insufficient attention to foundations. Most frequently this is in the form of neglect to remove the overlying material to secure a suitable foundation and cutoff and failure to provide a satisfactory bond between the underlying base and the overlying embankment.

A commonly overlooked safeguard is provision of the best possible protection against infiltration along the contact between embankment and foundation. Such protection must extend up the side walls as well as across the bottom of the streambed. The cutoff wall along this danger line either must be an absolute stop to water flow or it must so increase the path of percolation that the

TABLE 2—FEATURES OF MAJOR DAMS

Name	Height Above Streambed (ft.)	Height Above Foundation (ft.)	Storage Capacity (acre-ft.)	Drainage Area (sq.mi.)	Contents of Dam (cu.yd.)	Elevation Above Sea Level (ft.)	Remarks
Embankment							
El Capitan	217	270	118,000	190	2,679,680	770	Semi-hydraulic fill and heavy rock section both faces
Calaveras	205	220	100,000	100	3,461,000	775	Hydraulic fill
Upper San Leandro	190	220	41,436	31	1,248,000	475	Hydraulic fill
Arrowhead	180	200	47,000	6.85	1,500,000	5,114	Semi-hydraulic fill
San Pablo	168	205	43,193	35	2,200,000	328	Hydraulic fill
Priest	168	....	2,350	1.04	734,326	2,245	Hydraulic fill
Crane Valley	145	....	45,000	55	907,000	3,380	Hydraulic and rockfill
Lower San Fernando	142	....	18,900	14.2	2,827,000	1,142	Hydraulic fill
Almanor	135	....	1,308,000	503	1,532,800	4,515	Hydraulic fill
Henshaw	123	156	203,580	205	500,000	2,740	Hydraulic and rolled fill
Cajalco	194	200	100,000	40	3,600,000	1,371	Rolled earth
Bouquet Canyon	190	225	36,200	13.6	3,421,300	3,008	Rolled earth
Stone Canyon	162	220	7,960	1.36	729,900	850	Rolled earth
Puddingstone	147	180	17,398	12.84	864,328	982	Rolled earth
Santiago	136	156	25,000	62.8	789,000	810	Rolled earth
Lower San Leandro	135	....	13,800	43	622,000	243	Compacted earth
Coyote	127	165	30,000	116	1,130,000	798	Rolled earth and heavy rock section both faces
San Gabriel No. 1	320	370	56,000	205	10,260,000	1,481	Rockfill-impervious earth section
Salt Springs	313	345	130,000	185	3,000,000	3,958	Rockfill
San Gabriel No. 2	265	290	13,000	41	1,200,000	2,405	Rockfill
Bowman	171	175	63,000	28.9	300,000	5,567	Rockfill
Morena	167	279	65,800	119.5	335,000	3,049	Rockfill
Main Strawberry	144	170	18,000	27.3	330,000	5,620	Rockfill
Fordyce	140	....	46,800	30.15	416,645	6,480	Rockfill
Relief	139	145	15,120	27.8	136,984	7,340	Rockfill
Bucks Creek	122	128	103,000	28	351,693	5,168	Rockfill
Concrete Gravity							
Pardee	350	358	222,000	575	615,000	575	Curved in plan
O'Shaughnessy	312	427	360,000	459	660,000	3,812	Curved in plan
Exchequer	309	330	289,000	1,027	350,000	710	Curved in plan
Don Pedro	278	288	289,000	1,500	296,552	609	Curved in plan
Morris	245	325	39,300	209.6	450,000	1,175	Straight in plan
Mulholland	195	200	4,240	1	173,462	750	Curved in plan
Shaver	170	183	135,283	30.4	282,000	5,370	Straight in plan
Huntington	158	165	88,834	78.9	116,800	6,950	Curved in plan
Barrett	152	192	42,899	249.5	139,569	1,617	Curved in plan
Savage	145	167	56,321	98.6	83,000	492	Curved in plan
Lower Crystal Springs	140	154	54,000	25.5	157,200	288	Curved in plan
Scott	135	140	94,863	268	107,599	1,920	Straight in plan
Hemet	135	148	14,000	67	32,320	4,336	Curved in plan-masonry
Copco No. 1	132	247	77,000	4,300	70,312	2,613	Curved in plan
La Grange	131	....	.....	1,548	39,741	294	Curved in plan-masonry
Concrete Arch							
Pacoima	355	373	5,900	27.8	226,140	2,015	Variable radius
Spaulding	275	....	74,488	120.5	191,772	5,014	Variable radius
Big Santa Anita	225	235	1,370	10.8	76,184	1,325	Variable radius
Big Tujunga	204	244	6,250	82	108,250	2,304	Variable radius
Bullards Bar	191	199	31,489	484	48,876	1,632	Variable radius
Melones	166	187	112,500	900	92,913	723	Constant radius
Sawpit	150	162	476	3.27	56,239	1,375	Constant radius
Gibraltar	150	180	13,746	219	60,000	1,365	Constant radius
Juncal	142	160	7,064	13.9	40,000	2,230	Variable radius!
Big Creek No. 6	130	135	993	1,195	19,900	2,230	Constant radius
Hogan	125	130	76,000	363.5	120,000	654	Variable radius
Buttress							
Big Dalton	141	170	1,290	4.3	45,049	1,711	Multiple arch
Florence Lake	140	153	64,406	170.5	56,576	7,329	Multiple arch
Hodges	130	....	37,699	303	18,128	330	Multiple arch
Little Rock	125	158	4,331	66	32,070	3,260	Multiple arch
Murray	101	112	5,890	3.75	8,224	540	Multiple arch
Bear Valley	90		53,000	38	4,684	6,746	Multiple arch
Tiger Creek	100	103	524	9	13,500	3,586	Slab and buttress
Pit No. 4	70	120	2,000	4,787	42,675	2,458	Slab and buttress

resistance to flow will be sufficient to prevent passage of any considerable quantity of water, with resultant danger of saturation, piping, etc.

Another common defect in dams of this type is the addition of material to raise the original structure without first clearing off and properly scarifying the old top. Such a contact is not a suitable element to have in an embankment. Another common fault is the presence in the embankment of lenses or zones of poor material, quite likely resulting from borrowpit variation or from improper placement, not detected at the time of construction but making its presence known only by excessive, localized seepage through the dam. Such leakage is not necessarily dangerous so long as the porosity of the structure increases from the impervious membrane toward the downstream face, and so long as the water table on the downstream side of the dam is kept low in order to minimize the tendency toward removal of the materials and decreased stability of the section.

Conclusions

In the course of the six-year investigation differences of opinion among engineers were met frequently enough to indicate that several phases of dam design still are in process of development. This is constructive and wholesome. A much more disturbing condition is that dam designers too often fail to carry out fundamental principles of good design. This places emphasis upon the importance of just such supervisory control as has been exercised in California in recent years. To cite one instance of this failure: No less than 30 plans have been submitted for approval with curves in alignment of high-velocity spillways—a feature of spillway design so inadvisable that it should be ruled out except in very unusual cases.

However, more serious criticism falls upon construction than upon design. It is useless to make accurate and careful calculations for a concrete structure and then fail to give a corresponding amount of care to preparing the foundation, selecting materials and supervising construction. The best possible concrete is none too good for use in a dam.

The worst faults found in the recent critical review of California dams,

stated in the order of their frequency of occurrence, are as follows:

(1) Spillways inadequate in one or several of the ways listed above.

(2) Inadequate treatment of foundations. In dams of each of the types reviewed just a little more money spent on foundations or for preparing abutment rock would have resulted in a safer and stronger structure and minimized the necessity for later expenditures. Particular attention must be given to adequate clearing of the foundation. If there are faults or fissures in the rock or foundation these should be recognized as menaces to the structure and treated as necessity requires.

(3) Lack of protection against erosion. This is particularly important at the downstream toe of spillways, at abutments of arched structures and at all overpour dams.

(4) Poor materials and poor construction methods. These deficiencies occur in dams of all types and sizes. Improvement in technique of recent years has been such that now there is no excuse for poorly graded materials, faulty placement or the various bad results of improper handling.

Lateral Pressures of Cohesionless Soils in Retaining Wall Designs

By Donald W. Taylor
Research Associate in Soil Mechanics, Massachusetts Institute of Technology, Cambridge, Mass.

ANALYSES of the lateral pressures on retaining walls, bulkheads, etc., must take account of a number of items which are difficult to evaluate. Among them may be mentioned the yield of the wall, vibrations, seepage, cohesion, and drainage conditions, and the effects of seasonal variations. A design based only on statistical computations cannot, therefore, be considered final. On the other hand, the first step will usually be a statistical computation based on ideal conditions.

Fig. 1 represents the general case of a retaining wall with a sloping back, sloping surface of backfill, and resultant thrust having any desired obliquity. Using the classical assumptions of cohesionless backfill, plane surface of rupture, and "active" pressure, the resultant thrust, E, per unit length of wall is, as published in Walls and Dams by Mansfield Merriman:

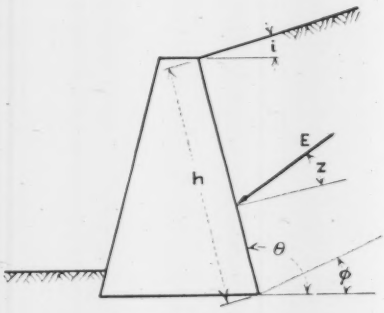


FIG. 1—FACTORS used in determining the thrust E on a retaining wall.

FIG. 2—NOMOGRAPH for determining factor K or the coefficient of $wh^2/2$ in the thrust equation.

$$E = \frac{wh^2}{2}\left[\frac{\sin(\theta-\phi)}{\sqrt{\sin(\theta+z)}+\sqrt{\frac{\sin(\phi-i)\sin(\phi+z)}{\sin(\theta-i)}}}\right]^2$$

in which w is the unit weight of the backfill; ϕ is the angle of internal friction of the fill, z is the obliquity of E to the wall surface, and the other factors are as shown.

The special cases investigated by Coulomb, Rankine, and Poncelet can be derived from this equation. For example, if $\theta = 90$ deg., $i = 0$ deg., and z is assumed as 0 deg., the familar Rankine form is obtained:

$$E = \frac{wh^2}{2}\frac{1-\sin\phi}{1+\sin\phi} = \frac{wh^2}{2}\tan^2\left(45^\circ - \frac{\phi}{2}\right)$$

This simple relation is often thoughtlessly used for conditions to which it does not apply, so that the nomographic chart given in Fig. 2 which makes the application of the general formula equally simple may prove useful.

In this chart the bracketed term in the general equation is represented by K. With this value determined the pressure intensity at the base of the wall is Kwh and the total thrust is $\frac{1}{2}Kwh^2$.

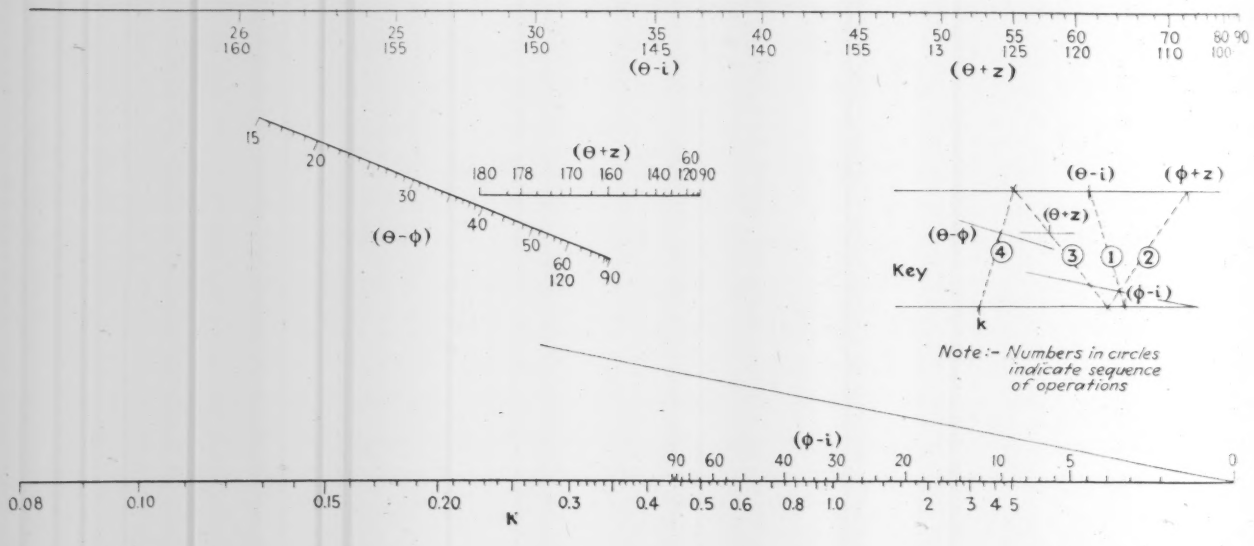
Illustrative Example:

$\phi = 38$ deg., $z = 30$ deg., $\theta = 95$ deg., $i = 8$ deg.

The angles for entering the chart are $(\theta - i) = 87$ deg., $(\phi - i) = 30$ deg., $(\phi + z) = 68$ deg., $(\theta + z) = 125$ deg., and $(\theta - \phi) = 57$ deg. From the chart $K = 0.28$.

The key indicates the sequence of operations in the use of the chart. The upper scale serves for both $(\theta - i)$ and $(\phi + z)$. Where double values appear, for instance, 35 and 145 deg., the angles have the same sine and the same point represents both.

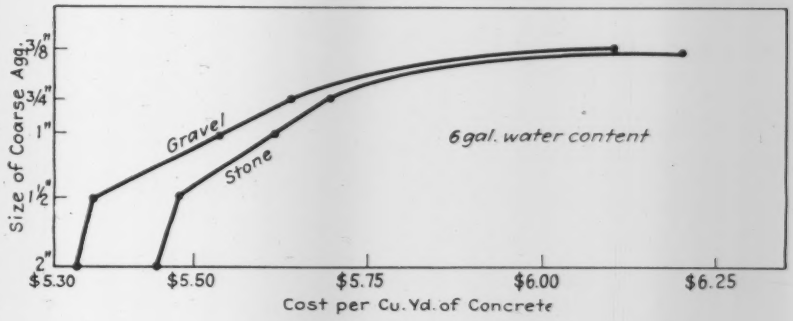
The value of the angle z is commonly taken for gravity walls as the angle of friction between fill and masonry, and for driven sheeting as 0 deg.



Convenient Concrete Table for Contractors' Use

By W. G. North
Vice-President, R. C. Wieboldt Co., General Contractors, Chicago, Ill.

IN order to promote efficiency in, and coordination between, its engineering, estimating, and construction departments, the R. C. Wieboldt Co., Chicago, has developed what it terms its "Engineers' and Estimators' Handbook." This book contains technical data pertaining to building materials, and tabular units of building construction.



CONCRETE COSTS are affected by the size of the aggregates. The curves relate to 3,000-lb. concrete having a 3 to 4 in. slump, and materials prices are for Chicago.

TABLE for 3,000-lb. concrete reproduced as it appears in the handbook.

ROW. CO. 11-1-35

SHEET 5

CONCRETE MIX - STRENGTH TABLE

1. STRENGTH REPRESENTS CRUSHING STRENGTH AT 28 DAYS.
2. WATER-CEMENT RATIOS INCLUDE MOISTURE IN AGGREGATE.
3. MIXES ARE GIVEN BY VOLUME. MATERIAL QUANTITIES ARE:- CEMENT IN BBLS. (4 SACKS=1 BBL.) FINE AND COARSE AGG. IN CY.
4. QUANTITIES ARE GIVEN FOR BOTH SURFACE DRY AND DAMP AGGREGATES. (SAND ASSUMED TO BULK 20%, GRAVEL 6% AND STONE 3% FOR DAMP AGGREGATE.)
5. FINE AND COARSE AGGREGATE APPLY TO CHICAGO MARKET.
6. SEE SHEETS 1 & 2 FOR DESCRIPTION OF AGGREGATES.
7. USE DAMP AGGREGATE QUANTITIES IN PRICING ESTIMATES.

MATERIAL QUANTITIES PER CY OF 3000# CONCRETE
WATER-CEMENT RATIO 6 GALS. PER SACK

3000 # CONCRETE

MIX	SLUMP 1/2" TO 1"		SLUMP 3" TO 4"		SLUMP 5" TO 7"		MIX
	1"C.AGG.	2"C.AGG.	1"C.AGG.	2"C.AGG.	1"C.AGG.	2"C.AGG.	
	SURFACE DRY AGGREGATE						
	1:2¼:3¼	1:2¼:4	1 : 2 :3	1: 2: 3½	1:1¾:2½	1:1¾:3	
	GRAVEL						
C	1.39	1.24	1.49	1.37	1.66	1.52	C
S	.46	.41	.44	.41	.43	.39	S
G	.67	.74	.66	.71	.62	.67	G
	STONE						
C	1.42	1.29	1.52	1.41	1.71	1.57	C
S	.48	.43	.45	.42	.44	.41	S
ST	.69	.76	.68	.73	.63	.70	ST
	DAMP AGGREGATE						
	1: 2.7: 3.4	1: 2.7 : 4.2	1: 2.4: 3.2	1: 2.4: 3.7	1: 2.1: 2.7	1: 2.1: 3.2	
	GRAVEL						
C	1.39	1.24	1.49	1.37	1.66	1.52	C
S	.56	.50	.53	.49	.53	.47	S
G	.71	.78	.70	.75	.65	.71	G
	1: 2.7: 3.3	1:2.7 : 4.1	1: 2.4: 3.1	1: 2.4: 3.6	1: 2.1: 2.6	1: 2.1: 3.1	
	STONE						
C	1.42	1.29	1.52	1.41	1.71	1.57	C
S	.57	.52	.54	.50	.53	.49	S
ST	.71	.79	.70	.76	.65	.72	ST

The concrete table reproduced herewith taken from the handbook differs from most concrete tables now in general use in that it combines mix, strength and quantities of materials, and differentiates between gravel and crushed stone aggregates. The table is based upon trial mixtures for various water-cement ratios. The quantities of materials were determined from apparent specific gravity and the weight per unit volume of the materials available. Similar tables for various other strengths of concrete are included in the handbook.

The concrete crushing strengths assigned to the different water contents per cubic yard are based upon Duff Abrams' original water cement-ratio curve A. Experience indicates that, with present day cements, the same strengths are attained under normal temperatures at 7 days instead of 28 days. Likewise, for the water contents given, the crushing strength at 28 days can be increased in each table by 1,000 lb. per square inch.

Many tables which have been published setting forth quantities of materials for various arbitrary mixes, or water-cement ratio strength mixes of concrete, have been based upon dry surface aggregates corresponding to laboratory conditions. These tables are designed to give quantities of dry aggregates and also damp aggregates containing the percentages of water customarily found in the local materials under average field conditions. On account of the shrinkage in volume of the bulked aggregates during the process of mixing the concrete, the units listed under "Damp Aggregate" should be used when computing the cost per cubic yard of concrete. Although it has been the practice in building construction to measure the fine and coarse aggregates by volume, knowing the unit volume weights of the aggregates, the tables can be readily converted to quantities

of materials by weight. The accompanying chart which appears in the handbook under "General Notes," illustrates how the material cost of concrete is affected by size and character of coarse aggregate.

In this General Notes section it is pointed out that the concrete tables have been prepared for 1- and 2-in. coarse aggregates only, since these sizes satisfy nearly all requirements. However, an approximation of mixes can be made for other size aggregates giving the effect in the quantities of cement and total fine and coarse aggregate factors compared with quantities required for 1-in. coarse aggregate which is expressed by the following percentages:

1½ in. aggregate decreases cement	6 per cent
No change total fine and coarse aggregate	
¾ in. aggregate increases cement	6 per cent
Decreases total aggregate	3 per cent
½ in. aggregate increases cement	20 per cent
Decreases total aggregate	9 per cent

Design Features of Denver's Newest Filtration Plant

Soft water from melting snows on West Slope will be brought through Moffat Tunnel to the city's fifth filter unit—pre-treatment facilities permit 40 per cent increase over normal filtering rates

By L. R. Howson
of Alvord, Burdick & Howson, Consulting Engineers, Chicago

UP TO THE PRESENT time Denver has secured its water supply from the South Platte River and its tributaries on the East Slope of the Rocky Mountains although it has long been recognized that unless West Slope water were made available the growth of the city would be seriously limited. The consummation of the Moffat Tunnel project is therefore of the utmost importance to Denver and vicinity. This article deals with only that part of the $8,000,000 Moffat Tunnel project diverting water from the Fraser River which is designated as the West Side filtration plant. Economic considerations dictated the utilization of this soft snow water for domestic consumption in the city rather than selling it for irrigation purposes. The new plant has the following design features of note: Pre-treatment through the use of modern flocculation methods and settling facilities enables the filters to run at much higher than normal rates; wash water detention is provided since gradual discharge into an irrigation ditch is planned in the summer while the water will be reused during the winter when the sludge will be allowed to accumulate in settling basins; over the operating gallery is a clear vaulted ceiling with supporting beams above the roof.

The natural flow of the Fraser River results from melting snow at high altitude (above 9,500 ft.) and is available only for four months in a normal year. Fortunately, those four months almost exactly coincide with the four months of heavy consumption in Denver during which the water use is about double that of the remainder of the year. The snow is in effect a reserve storage for peak demands. During this heavy run-off period the plant will be operated at maximum capacity so as to utilize as much of the flow as practicable for the public water supply rather than for exchange of irrigation. During the remaining part of the year the plant will be supplied from storage in the 12,000-acre-ft. Ralston Creek reservoir and will operate at a lower rate.

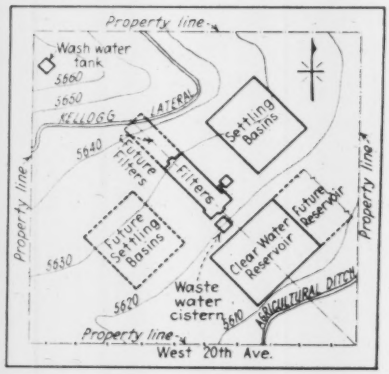


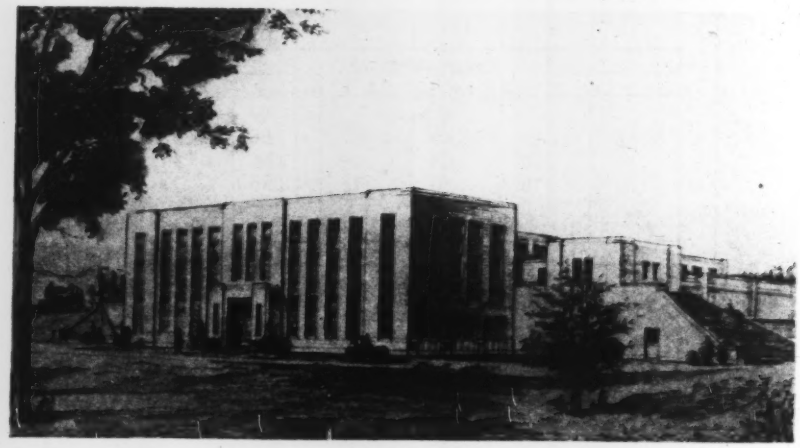
FIG. 1—THE PLANT layout fits the topography and is designed for future extension.

In preliminary studies the filter plant was tentatively located at the North Ralston Creek dam site, 10 miles from Denver. Subsequent detailed investigation disclosed that it would be practicable to select a site 3 miles west of Denver between Twentieth and Twenty-Sixth Sts. at such elevation that the clear-water reservoir could operate substantially as elevated storage in the high-service area of the Ashland Ave. district, providing the connecting main between the clear-water reservoir and that district was made sufficiently large. Use of this site will permit the abandonment of the present Ashland Ave. high-service pumping station, thus effecting an annual saving of the $35,000 now expended for its operation.

The filtration plant will be connected to the Ralston Creek storage reservoir through a 42-in. pipe line which will deliver up to 100 sec.-ft., 125 per cent of the plant rating, when operating at the hydraulic grade line at the filter plant.

The capacity of the plant was determined from a forecast of the water requirements for the city, together with an analysis of the existing filtration facilities. At the present time, Denver has four filter plants, namely, the North Marston mechanical plant built in 1926 with a rated capacity of 64 m.g.d., the South Marston and Willard plants, being of the old tub-filter type built in the nineties, and a slow-sand filter plant at Kassler, having a capacity of 30 m.g.d. The Willard and the South Marston plants have no adequate facilities for chemical mixing or coagulation. They are of wood construction housed in wood and sheet-iron buildings and

FIG. 2—ARCHITECTURAL conception of the West Side filter plant.



under ordinary measures of obsolescence, have already outlived their usefulness. They have, however, been continued in operation and have functioned reasonably well. It is felt that in building at the present time, it must be considered that the South Marston and Willard filters will soon be retired from service. As a matter of fact, their retirement will effect an annual saving of $45,000. The new West Side plant, together with the North Marston plant and the Kassler plant, will be adequate to care for all of the requirements at least to as late as 1950.

Another factor that had some bearing upon the capacity of the West Side plant, was the relative qualities of the West Slope water and the Platte River water. The former will have an average hardness of less than 2 gr. per gallon as compared to an annual average hardness of more than 7 gr. per gallon for the Platte River water. The saving in soap alone due to the use of the softer water will amount to approximately $225,000 per year which for the 25,000 acre-ft. available is equivalent to $9 per acre-ft., a figure some four and one-half times the revenue which it is practicable to secure from the sale of water for irrigation purposes. The highest and most economical use of the soft West Slope water is accordingly for municipal domestic consumption.

General layout of plant

As illustrated in Fig. 2 a symmetrical layout has been developed for the present construction and future enlargement both of which will fit the ground topography. The utilization of the 40-acre tract purchased by the city has been developed to provide for doubling the present installation of 56 m.g.d. without superseding any of the present investment. The settling basins and filters which have a higher flow line than the clear-water reservoir, are located on higher ground. Both settling basins and clear-water reservoirs are located so as to balance cuts and fills. The wash-water tank, located at the northwest corner of the property which is at 40 ft. higher elevation than the site of the plant proper, is underground. The topography lends itself admirably to a layout capable of economical expansion.

The head on the pipe line at the mixing chamber will vary from zero at 100-sec.-ft. flow to approximately 180 ft. with zero flow, that is, static level. The pipe line behind this valve is 7 mi. long. The control of water levels and surge is therefore an important matter. The pipe line discharges into a mixing chamber 40 ft. square by 15 ft. deep. Mixing will be effected by the velocity created by the tangential entrance of the pipe line. The water leaving the pipe line when flowing at full capacity will be at a velocity of approximately 14 ft. per sec. and during minimum winter

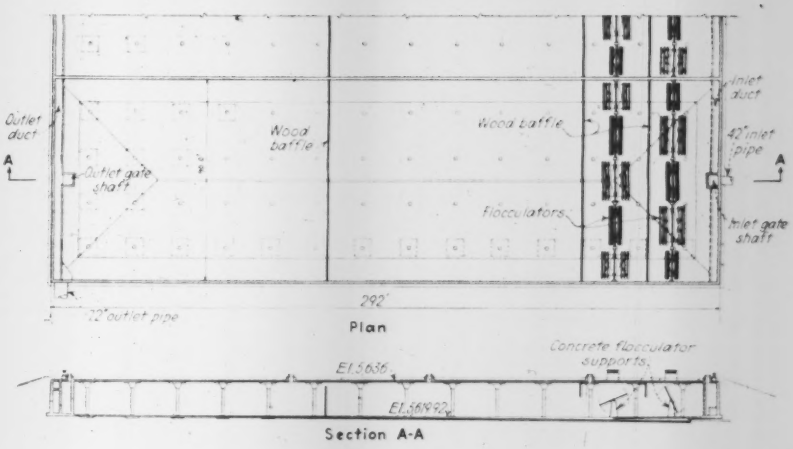


FIG. 3—DETAILS OF THE COMBINED flocculating and sedimentation basin layout showing the paddle wheel mechanism and wood baffles.

operations, the flow will be about 1½ ft. per sec. This mixing chamber is designed for a rapid pre-mix only, the slow stirring mixing to be applied in the settling basins.

The control of the pipe line without surge is automatic through a valve of the cone plug type actuated by the water level in the sedimentation basins. The basins are 300 ft. square. A 1-in. fluctuation in the water level control represents about 75-sec. storage at peak rate of flow; a 4-in. variation would store the peak rate for 5 min. As the valve would be closing during this period a 10 min. interval would be available with a 4-in. variation. This will result in a slow opening and closing action of the plug valve, so gradual that it is believed its operation should result in little if any surge. As a precautionary measure however, the inlet side of the valve is protected by two 8-in. automatic pressure relief valves which, through open discharge into the mixing basin, will relieve excess pipe line pressure to keep the head within the static range.

The type of mixing and the time allowed have been designed with relation to the water to be treated. The Fraser River water is very soft, carries little turbidity and reacts slowly with alum and lime. Laboratory experiments showed that with mixing periods of 10 to 15 min. a fine pin floc formed; with continued slow agitation or stirring for periods up to 40 min. or more the floc coalesced; at mixing periods in excess of 30 min. a good quick settling floc was produced.

As a result of these flask experiments a quick mixing period of between 4 and 5 min. of violent agitation created by the velocity of the water itself, was provided. This quick mixing basin immediately adjoins the filter head house so that only short runs of pipe from the chemical feeding equipment are required.

From the quick mixing chamber the water passes to a combined flocculating and sedimentation basin in three compartments (Fig. 3) each 90x290 ft. in plan with 15-ft. depth and providing a total of 40 min. in the flocculation compartment followed by 3 hr. of quiescent settling. The flocculators are of the paddle-wheel type. The peripheral velocity of the paddles will be about 1¼ ft. per sec. Both flocculating and settling compartments are of the flat-slab box-type of construction. The roof is covered with 1 ft. of earth for protection of concrete. Ventilating, and access manholes are provided at convenient locations.

The velocity of flow through the basin will be 1¼ ft. per min. About midway of the settling basin wood baffles are provided, all water being required to flow over the top of the baffle. In effect this divides the basin into two substantially equal compartments in series and thus obviates short circuiting and facilitates settling.

The water enters the settling basin through an inclined slot from a channel extending the entire width of each of the three basins. This slot is inclined to deflect the current backward. It is designed to effect uniform distribution across the width of the basin. The outlet is somewhat similarly controlled. The upper compartment of the outlet duct extends entirely across each basin, with a submerged weir of uniform cross section extending the entire width as well. At the center of each basin is a downshaft controlled sluice gate through which the settled water discharges into the lower outlet conduit, which in turn conducts it to the filters. In other words both the inlet and outlet to the basins are controlled by submerged weirs.

The filter plant proper consists of ten units, each having a rated capacity of 5.6 m.g.d. when operating at a rate of 2.8 gal. per min. per sq.ft. (175 m.g.d. per acre as compared with the standard 125 m.g.d.) This high rate is prac-

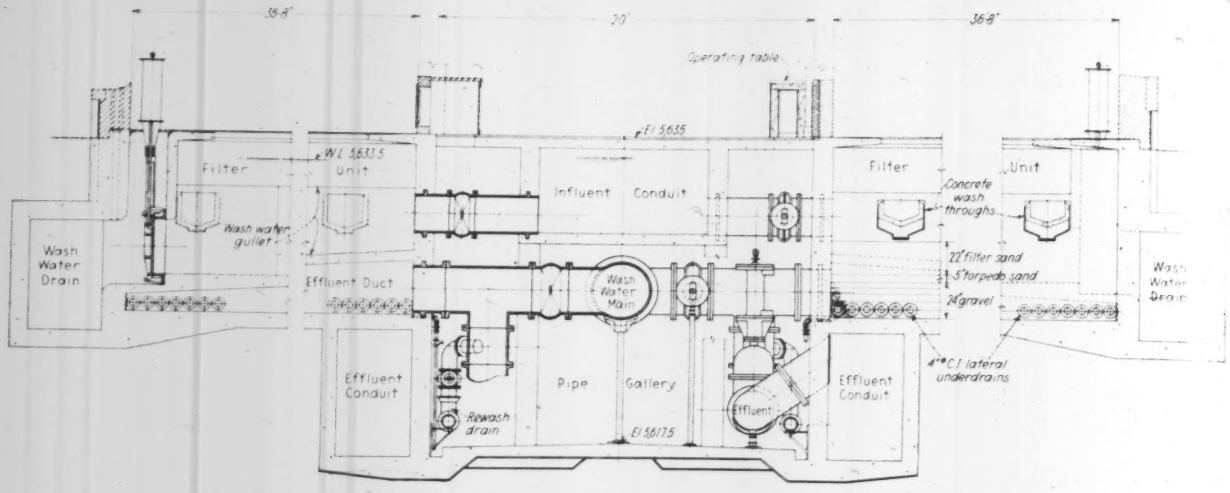


FIG. 4—SECTION THROUGH FILTERS and pipe gallery showing concrete influent conduit, wash water drains at outer ends of filters and effluent conduits along each side of gallery.

ticable with the excellent pre-treatment of the water to be provided.

The filters are of the central gullet type, each bed consisting of two separate units, each of 2.8-m.g.d. capacity, but operated from a single set of control valves. Laterals are of cement-lined cast-iron pipe, 4 in. in diameter, spaced at 9-in. centers. The gravel bed is somewhat deeper than ordinary and more closely graded. It consists of five layers with a total depth of 24 in., varying in size from 2½ to 1½ in. at the bottom to ¼ to ⅛ in. at the top. On top of the gravel will be 5 in. of torpedo sand and on top of that, 22 in. of filter sand having an effective size between 0.45 and 0.50 mm. and a uniformity coefficient between 1.25 and 1.50. Troughs will be of reinforced concrete.

All valves will be hydraulically operated from a central control table. Each operating table will be provided with a floc detector and each valve control will be provided with an illuminated precision indicator to show the position of corresponding valve or sluice gate.

The pipe gallery (Fig. 4) is of unusually liberal dimensions and so designed as to provide convenient access to all valves and equipment. The main raw water conduit is of concrete built directly under the operating gallery floor. Dirty wash water discharges to concrete drains, one built at the rear of each filter outside of the filter building.

Chemical weighing and feeding facilities are provided for handling alum, lime, sodium aluminate, powdered activated carbon, ammonia and chlorine. The points of application for these chemicals are laid so to provide maximum flexibility and reliability in plant operations. Feeding equipment is of the gravimetric type by which the rate of feeding is controlled through synchronous motor-driven weights on the scale arms. Chlorine and amomnia equipment are housed in separate, mechanically ventilated rooms. Chlorine will be stored in one-ton containers.

The effluent from the several filters discharges into conduits located underneath the filters on each side of the pipe gallery, and thence through a 6-ft. concrete conduit into the 10-m.g. reinforced concrete clear well located on lower ground in front of the building. This clear well is in two compartments, and is entirely underground.

Storage provided for wash water

In view of the fact that wash water must be disposed of in one of the local irrigation ditches and further that when washing at a rate to produce a 36-in. vertical rise (for which the filters are designed) the rate of wash water use will be 70 sec.ft., a concrete detention reservoir has therefore been provided for wash-water storage and gradual release. This reservoir, located underground immediately in front of the building, is 50 ft. square and 12 ft. deep. The capacity is sufficient for the storage of two filter washes. The outlet from this cistern is connected to the agricultural ditch by a 20-in. pipe line.

During the winter, when there is no water in the ditch and freezing would result from its use for the disposal of filter wash water, it is planned to pump the dirty wash-water back to the mixing basin and thus through the plant. With the normal winter operation at from 10 to 15 m.g.d. it will be entirely feasible to store the wash-water deposits in the sedimentation basins until it is practicable to discharge to the ditch.

Wash-water storage is provided in a 225,000-gal. reinforced concrete tank located on the high ground in the northwest section of the property. This tank is connected with the pipe gallery through a 36-in. cast-iron pipe.

It is necessary to pump the wash water and, at certain seasons of the year, to return wash water to the sedimentation basins. For this purpose three wash-water pumps are provided to lift water from the clear well to the wash-water storage reservoir, each having a capacity of 5 m.g.d.; two pumps of 2½ and 5 m.g.d. capacity respectively will be used to lift the water from the cistern to the mixing basin unit.

The filters are housed in a one-story brick building, 104 ft. x 270 ft. in plan dimensions. The head house is three stories in height. That part of the building over the filters is lighted solely from skylights and the operating gallery monitor. The exterior walls resemble a panelled garden wall perfectly blank so far as windows are concerned. Directly above each of the ten filters is a skylight having an area, equal to 20 per cent of the filter surface. The roof is of concrete on structural steel beams. As there are no columns the entire area of each filter is unobstructed. The concrete roof is covered with 1½ in. of cork insulation.

The building superstructure is of simple substantial design, built of local grey brick with stone and terra cotta trim. Office, laboratory, chemical feed and all control apparatus are conveniently concentrated for efficient operation. The roof of the operating gallery is of rather unusual design. The span of more than 20 ft. is roofed by a vaulted ceiling with longitudinal beams at the walls tied above the roof at intervals by a concrete beam.

The Moffat Tunnel project is being executed under the Board of Water Commissioners of the City and County of Denver with Col. Herbert S. Crocker, consulting engineer in charge. Alvord, Burdick and Howson prepared the plans and specifications for the West Side filter plant with Victor A. Matteson associated on architectural design.

REGULATING TRANSPORT—VI

Conclusion on Regulating Transport

By John S. Worley
Professor of Transportation Engineering, University of Michigan, Ann Arbor, Mich.

OUT of these reflections on regulating transport that have run through five issues of *Engineering News-Record* certain determinations have been clear. To put them in usable form is the purpose of this concluding article. In concluding also the writer repeats that he has not attempted a rounded discussion of regulation but merely to express in informal manner his reflections as a detached observer of transport happenings. The conclusions that he arrives at are:

1. No evidence was found in support of the belief that the United States was facing a national transportation problem and it seems reasonable to assume that no such problem exists.

2. While we have no national transportation problem, each type of transportation and many agencies under a particular type, have difficulties inherent to their particular business. These difficulties may have been aggravated because of the economic depression which began in 1929; however, they appear to be no more serious than those of many other forms of business endeavors. Their correction must come through the efforts of their own executives and not through legislative enactments.

3. Regulation by legislative bodies or bureaus to whom legislative authority is transferred, should be confined to enactments in which there is a strong presumption of public benefit.

4. Regulation should always be the minimum in amount, and then only in the form of restraints or where legal requirements are such that permission must be granted.

5. The amount and degree to which the service is generally used should be a strong factor in determining the necessity of regulation.

6. As a rule regulation should be predicated upon complaints of transportation agencies by the consignor and consignee.

7. Where laws and regulations are needed to aid the private transportation agencies they should be passed only when they are not a public detriment.

8. The attitude of the government or legislative and regulatory bureaus towards our transportation companies as long as not against public interest should be one of granting maximum freedom in the operation of the respective properties.

9. The regulation of any business is no criterion for the regulation of another either in kind or amount. However, when regulation for a particular transportation agency is found necessary the same should be applied to all of its type; that is, no discrimination should be shown between one bus company and another, or between one railroad and another, or between one motor-truck operator and another, or between one steamship company and another, or between one air transportation company and another.

10. Laws and regulations which pass beyond the boundary of restraint or permission have a debilitating effect by destroying executive ability.

11. A transportation agency of a monopolistic nature, part of its services being competitive while the other is noncompetitive, should be permitted to reduce its charges for services in order to secure business available or regain business lost. It, however, should not be permitted to reduce its rates to a point below cost and where rates are reduced to meet competition resulting in loss, permission should not be given to make up losses by general increase in all rates or increase of rates on services of a noncompetitive nature.

12. There is no evidence of the destruction of the railways in the United States due to unregulated competition. The railways at this time move more than 80 per cent of the ton miles of freight and receive more than 80 per cent of the gross revenue from freight movements. In the matter of passenger traffic the railways have lost more than three-fourths of the business which they enjoyed in 1920. However, only a very small part of this has gone to other competitive transportation agencies. The majority is being moved by private automobile and probably is no longer potential railway traffic. There seems to be no reasonable expectation that this condition will change and there seems to be no evidence that it would be in the public interest that it should.

13. Every transportation agency should be permitted to adjust its plant and operations to the present and probable immediate future traffic. Such an adjustment would be much in the interest of the transportation agencies themselves and the public at large.

14. Coordination is an ill defined term which should not be adopted as a plan of procedure until there is an approved definition.

15. The government should lend aid and advice and should encourage the improvement of each individual transportation company.

16. Coordination of transportation companies of a particular type should be encouraged through such laws and relaxation of regulation as will assist and accomplish this.

17. Coordination as applied to all transportation agencies is of very questionable value and whenever undertaken should first be within each individual corporation, then between the agencies of a particular type, and finally such coordination between transportation types as would appear to be of a positive public benefit.

18. The creation of a few great transportation companies each of which would be engaged in railway, airway, water and highway transport, by which a few companies would be given the sole and exclusive right for the transportation of passengers and freight in the United States, both intra- and interstate, is a questionable proposition and should not be undertaken until most thorough studies have been made to determine a public benefit. If, after these studies are made, a public benefit does appear positive, then such transportation systems should be established.

19. The particular service which any transportation agency can best render and be to the greatest public benefit should be determined by the demand of the public for that service and should not be determined by a governmental bureau or administrative officer.

20. To accept the fundamental principle that an individual or corporation is to be denied the right to invest money with the attendant risk for what the investor thinks a better and more satisfactory service is indeed questionable. The proposal of Mr. Eastman that in the development of all new oil fields the right to build and transport oil through pipe lines is to be prohibited, is in this category.

21. The theory that governmental officials are more competent to pass upon policy and administrative details in connection with managerial affairs is not sound and should be rejected.

22. Monopoly by legislation by which new effort and capital are excluded is a questionable policy. The success of the operation of transportation agencies is dependent upon the same principle as has governed all other types of public utilities and private business. This success has always been dependent upon the efforts and capabilities of the executives in charge. Where the government assumes the responsibility or dictates as to managerial policies and administrative details, it is to be expected that the operation of the properties will be of a very mediocre character.

Research Reported to the A.S.T.M. Convention

Studies in cement and concrete, steel, iron and bituminous materials provide new data for the specifier and the manufacturer.

Conclusion of report begun last week on the activities and developments at the Atlantic City meeting, June 29-July 3.

RESEARCH in cement and concrete was reflected on the program by about a dozen papers whose essential content is briefed below.

At the University of Illinois a series of tests comparing shrinkage of haydite and ordinary sand-gravel concrete using 4x8-in. cylinders as test specimens revealed that haydite concrete does not follow the usual relation between water loss and shrinkage. For example, during the first two months there is extremely high water loss and low shrinkage. After two years, however, the shrinkage slightly exceeds that recorded for sand-gravel concrete. The probable reason is the higher water-cement ratio of the haydite concrete necessary to produce the same slump as for the sand-gravel concrete, this higher ratio resulting from the water absorbed by the porous haydite aggregate. The tests were described in a paper by F. E. Richart and J. E. Keranen.

Concrete aggregates studies

A series of tests on the standard sodium and magnesium sulphate soundness test for aggregates reported by Stanton Walker (National Sand and Gravel Association) provided reason for Mr. Walker to urge that the tests be modified or that they be used only as a guide to quality rather than as a basis for rejection. Difficulty is experienced in securing uniform results, because the temperature of the solution and its degree of saturation have important effects and are difficult to control. Discussion admitted the difficulties, but claimed that they could be overcome by ordinary precautions.

A study reported by Fred Hubbard of the Standard Slag Co., covering tests on over 1,000 6x12-in. cylinders and some 350 6x6x48-in. beams showed slag aggregate to be no better and no worse than natural stone, although slag does not meet some tests required of stone aggregates, such as the Deval abrasion test. The concrete making properties of slag aggregate are directly comparable to those of stone aggregate, and it is concluded that special and restrictive specifications are unnecessary. The requirement that best assures good slag concrete is a specified weight per cubic foot.

An interesting procedure for visual rating of the characteristics of fresh concrete as a supplement to information supplied by tests was described in a paper by Harmer E. Davis and J. W. Kelly of the University of California, and presented by G. E. Troxell of that institution. It consists of listing the characteristics to be rated such as consistency, workability, tendency toward segregation, cohesiveness, placeability, and appearance of formed and unformed surfaces. The ratings given each property are combined into a "quality index."

Speed of testing

On the important question of the speed of testing and its relation to results, Paul G. Jones and F. E. Richart, of the University of Illinois, reported an investigation of compressive tests on 6x12-in. concrete cylinders loaded to failure in periods of 5 sec., 20 sec., 1 min., 2 min., 10 min., 30 min., 1 hr. and 4 hr. The corresponding rate of stress application was from 3,870 to 0.12 lb. per sq.in. per sec. Load and strain were measured by carbon pile telemeters. It was shown that strength increases with increased testing speed, the ratio of strengths for highest and lowest rate being about 1⅓ to 1. The secant modulus of elasticity also increases. The tests indicated that creep accounts for some of the strain, the amount of creep increasing with the length of the test but not being proportional to the intensity of stress. In discussion, H. F. Moore (University of Illinois) pointed out that because of the various types of testing machines now used, motion of the head can no longer be considered a good measure of the speed of loading. The telemeter, of course, eliminates this problem of variability.

Surfaces of mortar cubes

The effect of departures from planeness of bearing surfaces of specimens used to determine the compressive strength of 2-in. cement mortar tubes was discussed by J. R. Dwyer (National Bureau of Standards). The specifications allow no capping of the specimens and permit the bearing surfaces of the molds to depart from a plane surface as much as a mid-ordinate of 0.002 for old and 0.001 for new ones.

Little effect by uneven bearing was noticeable when the surface was convex, and little appeared for concave surfaces until the specimens were four days old. The effect became quite evident on the 7-day test when the mid-ordinate was as much as 0.004. Relative strengths were lowered as much as 8 per cent in tests of 28-day specimens with this deviation. Differences of as much as 3 per cent were found with the 0.002 mid-ordinate in the 28-day test.

Cement fineness test

A hydrometer method of determining the fineness of portland-puzzolan cement, now being used as one of the acceptance tests for cement for Bonneville dam, was described in a paper by S. B. Biddle, Jr., and Alexander Klein of the University of California. The tests are being conducted in the San Francisco laboratory of the National Bureau of Standards. This method was developed because the puzzolanic components of the cement are so translucent as to make the results obtained by the turbidimeter uncertain.

Low-temperature curing

A paper on the influence of curing at low temperatures on the hardening of cement mortars by S. A. Mironoff of the Central Institute for Industrial Building Research, Moscow, was presented in abstract form by J. C. Pearson (Lehigh Portland Cement Co.), who stated that the paper purported to show considerable advantage through curing concrete at low temperatures. Mr. Mironoff's tests were carried on at temperatures close to freezing, about 2 deg. C. He lowered the temperature of the mortars used in his test to freezing immediately after mixing and continued them for periods extending from 3 to 28 days, permitting the mortar temperature to rise to normal temperature for final hardening of the mortar. Compared with specimens permitted to harden in the normal way at normal temperatures, the specimens initially lowered to freezing temperature showed better ultimate strength.

From his tests Mr. Mironoff concludes that there are advantages to be gained in laying concrete roads in winter, permitting them to freeze and stay frozen until milder weather permits the final hardening to take place.

Commenting on the practical application of Mr. Mironoff's theory, Mr. Colborn of the Marquette Cement Co. said that it might be possible to control outside temperatures in Russia, but that it was not possible to do so in this country and that as a result concrete placed in the open might be exposed to temperatures far below freezing with quite different results.

P. H. Bates stated that he had had an opportunity to make some comparative tests since seeing Mr. Mironoff's paper. He made some test specimens, sealing them to prevent evaporation and submitting them to temperatures of 37 deg. F. for varying periods. For

his test he used portland cements of varying heat of hydration, also high-early-strength portland cement. His tests show that curing at low temperatures for a long period has little effect upon the ultimate strength of some cements, although a material increase in the ultimate strength of others was recorded. He indicated that the heat of hydration appears to have some bearing upon whether or not low temperature curing produces higher ultimate strength. Mr. Bates also called attention to the fact that the term "freezing temperature" in Mr. Mironoff's paper is inaccurate, since his tests were carried on at just above freezing temperature.

Petrographic studies of hydrated cement, conducted by L. S. Brown of the Lone Star Cement Co. and R. W. Carlson of the University of California were reported by Mr. Brown. Mr. Brown stated that a practical conclusion to be drawn from their studies was that cement mortars are inherently porous.

D. O. Woolf of the U. S. Bureau of Public Roads described a cone method for determining the absorption of sand that has been developed by the staff of the bureau. The basic principle of the test is that sand containing free moisture, when tamped into a small truncated cone, will retain its molded form when the cone is removed, whereas if there is no free moisture and the sand is surface dry, the sand will slump from its molded form upon removal of the mold. The method has been adopted by the American Association of State Highway Officials for use in its standard method of tests for specific gravity and absorption of fine aggregates.

Ira Paul of the New York State highway department questioned the efficiency of the cone method and outlined briefly a modification of the kerosene method that he has developed, which, he stated, gives better results in much less time.

Metals testing

Two papers in the session on testing outlined respectively the use of a novel wedge extensometer and the further development of high velocity tension-impact tests which were suggested in the paper presented last year, for which this year's Charles B. Dudley medal was awarded. The wedge extensometer was described in a paper by Wilbur M. Wilson (University of Illinois) which was presented by Professor Richart. It consists essentially of a steel wedge with a given taper and some suitable means, usually an Ames dial, for measuring the movement of the wedge caused by deformation or slip of the material being studied. The paper described the satisfactory use of the wedge extensometer in a variety of tests including determination of the vertical deformation of concrete under a steel slab, of slip in a riveted joint, and of the bearing value of steel cylinders. In discussion, F. G. Tatnall (Baldwin-Southwark Corp.) referred to the use by the American Rolling Mill Co. of a commercial instrument of this type for thin sheet metal testing.

High velocity tension impact tests

An explanation of why metals which satisfactorily pass required impact tests sometimes fail in service was presented in the paper on high velocity impact tests by H. C. Mann, Watertown Arsenal. Using a special apparatus capable of producing velocities up to 1,000 ft. per sec. (whereas 30 ft. per sec. is about the largest experimented with previously), Mr. Mann showed how each metal has a definite "transition velocity" beyond which the energy that it may absorb without failure drops off rapidly. Velocities up to 350 ft. per sec. were used. This transition velocity is usually far above any velocity attained by conventional impact machines but, according to Mr. Mann's theory, it is sometimes exceeded in service with a resulting failure. He concludes that for dynamic loading, normal behavior may be expected within the transition velocity (which is measurable), and that consideration must be given to the ratio of total energy value to the mass or volume of material and to surface irregularities. Also, that high-velocity tension-impact tests reveal the true dynamic properties of materials whereas the ordinary type of test merely indicates the general effect of specimen geometry or form. A written discussion by M. O. Withey (University of Wisconsin) complimented Mr. Mann on the paper and H. F. Moore (University of Illinois) pointed out that Mr. Mann had ventured into a fruitful field in taking up the kinematics of stress. One problem which needs attention is the manner in which stress or strain energy is distributed. Professor Moore instanced simple beams subjected to dropped loads which exhibit an elastic curve suggesting fixed ends.

Asphalt research

A group of five papers contributed by members of the research staff of the Barber Asphalt Co. furnished some significant new data in the field of asphalt paving mixtures and comprised the bulk of the program for the session on bituminous materials. The contributors were G. L. Oliensis, R. N. Traxler, H. E. Schweyer, C. E. Coombs and Roland Vokac. In three of the papers, presented by Mr. Traxler, the falling coaxial cylinder type of viscosimeter played a prominent part. It has been selected by the company as the best type for rapid and accurate determination of viscosity, and a study of 25 different sizes of the instrument resulted in the selection of a relatively small one in which the radius of the outer cylinder is $\frac{3}{4}$ in., of the inner cylinder $\frac{1}{2}$ in., and the cylinder length 1 in. The apparatus that incorporates this viscosimeter will measure viscosity in 10 to 100 sec. over a range from 5,000 to one billion poises.

A second paper described a study of asphalt susceptibility (the change of consistency with change of temperature). The study developed an asphalt viscosity index defined as the per cent change in viscosity per deg. C. which can be applied to asphalts at both processing and service temperatures. The processing viscosities were determined by the Saybolt Furol viscosimeter and the service viscosities (at 59 to 95 deg. F.) by the coaxial cylinder apparatus. In these temperature ranges a log-viscosity versus temperature plot is a straight line, and the index is a function of the slope of this line. Its use makes it possible to compare quantitatively the susceptibility of various asphalts at the high viscosities at which they are used and at the fluid consistencies at which they are handled. For these two temperature ranges the indices of each asphalt are greatly different in magnitude. Furthermore, the relative order of the susceptibility for the various asphalts may be different in the two ranges. The study was not made with an idea of setting up susceptibility as a quality test but merely as a part of a general research program.

Another use of the falling coaxial cylinder viscosimeter has been in the study of aging, that is, the increase in viscosity with time. From the data obtained it is evident that certain asphalts age harden more rapidly and extensively than others and that the phenomenon in air-blown asphalt is different than in steam- or vacuum-refined materials. Adding mineral powder to an asphalt has very little effect on the rate of age hardening. An asphalt aging index was proposed to evaluate quantitatively the rate of increase of viscosity with time. By plotting a log-viscosity versus log-time curve, straight lines are obtained, and the index is the slope of these lines. The paper states that development of a thermally unstable structure within the asphalt is probably the cause of the age-hardening phenomenon.

Mr. Oliensis, who had developed the so-called spot test in 1933 for detecting cracked asphalt, steam refined or vacuum processed residuals that have accidentally been subjected to higher temperatures than normal and the more highly blown asphalts that have been subjected to the higher temperatures for prolonged periods of time, outlined a further study of the heterogeneity of asphalt in which by a modification of the spot test it is made applicable to asphalts containing waxy bodies, acid sludge bodies and incompatible fractions. In effect, the spot test is shown to determine heterogeneity quantita-

tively, whereas previously it was regarded only as a qualitative determination. Instead of straight naphtha, mixtures of naphtha and xylene are used as the solvent, the minimum proportion of xylene necessary to yield a negative spot determining the degree of heterogeneity. The paper shows how various types of heterogeneity may be corrected by mixtures of homogeneous asphalt or xylene. Also that gilsonite is apparently the most efficient homogeneous asphalt to be used in correcting heterogeneity due to waxy bodies and that xylene is the most efficient in correcting that due to cracking or overheating. The new quantitative test is of most value to the plant or refinery chemist since the user is only interested in whether an asphalt is heterogeneous or not.

Mr. Vokac presented a paper on the compression testing of asphalt paving mixtures in which such fundamental characteristics as modulus of elasticity in compression, compressive strength and elastic limit are readily evaluated. In the testing work, applying loads for a uniform rate of deformation was found to be more practical than applying a uniform rate of increase of load on a specimen. The most successful rate of deformation used was 0.05 in. per minute. Also, room temperatures (78 deg. F.) are best for such testing. So far as test specimens are concerned, it has been found necessary to limit the height to not less than three-fourths the diameter. Any conventional testing machine may be used.

The paper also presented equations for determining the modulus of elasticity and the compressive strength in terms of density, a development that eliminates the necessity for making all briquettes of the same density. This was pointed out as making it possible to evaluate the constants of a mixture on the basis of cores cut from a pavement in which the cores are rarely either of the same height or density.

Forecasting Trends In Sewage Disposal

Physical treatment processes will next claim attention and biological and chemical methods will be improved to give greater stabilization at less cost

RAPID ADVANCES in the art of sewage treatment lend interest to frequent recapitulation of the trend of progress as related to future development. This extract from a paper by Dr. Willem Rudolfs presented at a meeting of the Maryland-Delaware Water and Sewerage Association at Frederick, Md., on May 15, carries a note of prophecy based on past and present experiences. —EDITOR.

DESPITE the rapid accumulation of information on biological treatment methods made during recent years and the utilization of these findings to improve operation, interest in non-biological sewage treatment is increasing and probably will continue to do so for several years. This may be accounted for principally by (1) the trend toward mechanization of equipment and the fact that biological processes are becoming more and more complicated, requiring increased skill in handling and scientific control, (2) the fact that engineers feel more at home with non-biological processes which allow them (presumably) to make definite calculations concerning construction and operation, and (3) the greater commercial interest in promoting mechanical and chemical processes than the biological schemes.

Biological methods more complicated?

It is generally assumed that non-biological methods, such as chemical coagulation, are inherently less complicated than biological methods. This is not necessarily the case. At present more is known about biological treatment, both from the standpoint of operation and the possible results to be obtained than about chemical processes. However, it should also be kept in mind that most biological treatment processes can be improved and applied with greater effectiveness. The same will probably hold for chemical coagulation when the factors involved are more clearly understood.

In cases where purely physical methods are involved the degree of purification can be increased over present methods, but theoretically at least, it is doubtful that physical methods can accomplish as much stabilization as biological methods. In order to accomplish greater purification and stabilization of sewage solids and liquids more complex chemical and physical methods will be developed. It is not conceivable that the mere addition of chemicals and the construction of simple apparatus will be the only requirements for a high degree of treatment at a low cost.

Chemical treatment less costly?

Frequently it is assumed that non-biological methods of treatment are less costly than biological methods. With our present knowledge this is probably correct for the intermediate type of treatment where not more than 80 per cent suspended solids removal and not more than 75 per cent biochemical oxygen demand reduction are required. Plant-scale experiments indicate that for higher degrees of treatment than those mentioned, chemical coagulation becomes in general economically unsound, requires extremely careful control and is apt to produce irregular results. Putting it differently: A certain amount of energy must be expended for the destruction or stabilization of waste material. When natural forces are employed to stabilize putrefactive material energy is supplied by the source itself under favorable conditions.

When the destruction or stabilization must be accomplished solely by the energy applied the ultimate cost may be considerably greater. For instance: It is comparatively easy to remove 90 per cent or more of the suspended material by the addition of proper chemicals. It is even conceivable that the same removal may be accomplished by physical means such as stirring mechanisms in conjunction with fine screens or filters and settling tanks. But in order to remove a similar percentage of biochemical oxygen demand an entirely different picture presents itself. A certain amount, roughly one-third, of the biochemical oxygen demand is in soluble form. Even with the best known coagulants the material causing this biochemical oxygen demand cannot be removed economically. Extensive experiments with chemicals, theoretically assumed to be more effective than the better known coagulants, show that this soluble material cannot all be fixed readily or removed economically. Chemical reduction of B.O.D. cannot compare with biological methods which promote hign removal.

Removal of this B.O.D. cannot be accomplished by physical means, even when all the suspended solids and bacteria are removed. Although the removal of soluble material causing B.O.D. can be accomplished by physical-chemical means such as are commonly known as base-exchange processes (zeolites) complicated apparatus is required which leads to complexity of control and increased cost of operation.

Future possibilities

What are the possibilities in the future: Will biological treatment be abandoned and reliance placed solely upon chemical and physical methods—will chemical treatment be used only in isolated cases or as an auxiliary to biological treatment — will sludge be handled entirely by physical means?

I have no doubt that the present trend of seeking for non-biological processes will continue to increase during the next few years. The basic information

we are collecting on chemical coagulation shows that in the future we will be able to produce a sparkling, clear effluent constantly and at will. The same information indicates however, that the production of stable effluents is difficult and costly. This automatically limits chemical treatment to an intermediate type of treatment which may be used the year around where sufficient dilution is available, or where only seasonal treatment is necessary for protection of bathing places or to prevent nuisances.

The possibility of using extremely fine screens or filters to produce a clear effluent (with 100 per cent removal of suspended matter) has been proven in the laboratory. Sewage has been filtered at rates of 200 million gallons per acre per day to produce an effluent from which 80 per cent of the suspended solids are removed; filtering at a rate of 750 m.g.a.d., with the removal of 70 per cent suspended solids, has been accomplished in an experimental plant without the addition of chemicals. There is no apparent reason why the rate of filtering sewage through a few inches of sand cannot be increased to a billion or more gallons per acre per day, producing the same or even better results.

Dewatering and incineration of sludge will be progressively improved but the complexity of equipment will increase accordingly. Operation will therefore be more exact and costs will be greater. While smaller communities will take advantage of the developments wherever possible, the sludge digestion process will be used for a great number of years to come.

The possibilities for improving existing biological processes hold excellent promise. We are rapidly piecing together fundamental facts that explain obscure phenomena. For instance we know the organic load a given quantity of activated sludge can handle, or in other words, in order to maintain a certain level of purification it has been determined that a given number of pounds of dry sewage solids can be handled in a certain time by a definite amount of dry activated sludge. Studies show that environmental factors can be changed to increase or decrease the purification capacity of the activated sludge. It is therefore only a question of further study to improve the available mechanism or change certain environmental factors so that stable effluents can be produced at a higher rate and at lower cost.

The work of Blunk in Germany and of Halverson in this country shows that the trickling filter process may be greatly improved.

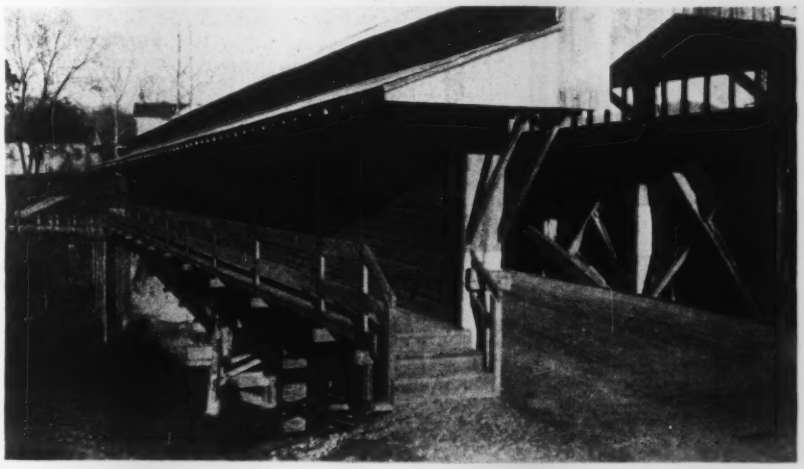
Even with our present knowledge, biological treatment will be preferable in certain instances.

Neither chemical nor physical nor a combination of these methods will replace biological treatment for many years to come. Chemical and physical methods have their place but they are limited in use to intermediary, seasonal and auxiliary treatment. It seems apparent that in the next few years considerably more will be heard about physical methods of treatment.

Reinforcing an Old Timber Bridge

By Arthur K. Erb
Bridgeport, W. Va.

AN OLD timber bridge on U. S. Route No. 19 south of Weston, W. Va., carries some 2500 vehicles per day and in addition is used by a good many children bound for a nearby schoolhouse. Inasmuch as the inside clearance is only 14½ ft. a very real traffic hazard existed and it was proposed to construct a sidewalk along one side of the structure.



RECONSTRUCTED TIMBER BRIDGE in which old arch span of 114 ft. is changed to two beam spans of 57 each by inserting steel girders beneath the floorbeams.

The bridge was built about 1880, mostly from yellow poplar and previous examinations had shown that the arch ring was failing due to rotting of the members at the springing line. The floorbeams, stringers and upper chord members were all in fairly good condition. The verticals, however, were no longer effective because the flattening of the arch had ruptured the timbers at the connections. Under these conditions it was not the part of good judgment to attempt to hang anything more on the poor old bridge, without strengthening it.

The method of reinforcing was not by any means unique, but it was effective and will provide many years of service with a minimum of expenditure. As illustrated, a center bent, using 12x12 in. timbers 27 ft. long was placed, with the posts jetted through 3 ft. of silt to the rock streambed. On this were placed two lines of 26 in. 151 lb. girders close enough to the floor beams that wedges could be inserted to take the weight off the arch ring. After the girders were in place the arch served only to provide stiffness and an additional factor of safety. At the abutments the girders rested upon sills which were placed directly upon the existing masonry.

The sidewalk was constructed on brackets using 3x6 in. stringers and cantilevers, 2-in. sidewalk planks and ⅞-in. round steel rods for suspenders. Two lines of 2x8-in. plank hook-bolted to the suspenders form the guard rails. A light roof was added, and an approach on one end completed that part of the work.

To reinforce the vertical members ⅞ in. cables were brought under the floorbeams, over the upper chord and taken up with turn-buckles. A new 3-in. floor was laid lengthwise over the old floor. All timber and lumber used was Southern yellow pine and all connections in the bents as well as sidewalk cantilevers were secured with bolts and cast iron washers. Special home-made clips to fit the 26 in. girders were used to secure the ends of the girders to the cap pieces and sills. The bridge is 127 ft. long with a span of 114 ft. between abutments.

Building Organization of Treasury Department Reorganized

Engineering forces of Procurement Division decentralized, design separated from construction in main office and an inspection unit created to cope better with the large current program.

Washington Correspondence.

WITH over 500 construction contracts of federal buildings ranging from $50,000 to $10,000,000 in cost, in course of execution and with 3,000 buildings to keep in repair throughout the United States and its islands, it has been necessary for Rear Admiral C. J. Peoples, director of the Procurement Division of the U. S. Treasury Department, to have the engineering division of his office reorganized and strengthened. He assigned this task to Neal A. Melick, an Ohio engineer who has been connected with the public works activities of the Treasury Department since 1909, and, under the title of supervising engineer, Mr. Melick has set up a decentralized organization in the field, employing more than 400 construction engineers. This is in addition to the headquarters staff in Washington where fifty more engineers are employed.

Eight construction districts

The country has been divided into eight districts. Each district is in charge of an engineer whose past experience has qualified him particularly for such responsibilities. Each district engineer has been given broad authority so that only matters involving policy controversies, or change orders of construction contracts have to be referred to Washington. In this way many of the delays that characterized the old organization under a supervising architect no longer occur.

The district comprising the Northeastern states has its main office in Boston where E. G. Shuring is in charge. A. B. McCulloch is the engineer administering the district made up of New York and its metropolitan area. The district office for the Middle Atlantic States is in Washington with H. S. McAllister in charge. H. G. Rickey is the engineer in charge of the Southeastern district with headquarters at Atlanta. Chicago is the headquarters for the district made up of the Great Lakes states. A. A. Packard is in charge. Another district is comprised of Northwestern states with W. N. Collier as chief. His office is in Kansas City. The Southwestern states make up the seventh district. I. D. Porter, with offices at Dallas, is in charge. The eighth district is made up of Pacific coast states and the adjoining states of Idaho, Nevada, Utah and Arizona. W. A. Newman is in charge of that district with offices at San Francisco.

There is an assistant district engineer, an inspection engineer and two mechanical engineers assigned to each district office. They have their necessary complements of draftsmen, clerks and stenographers.

ROOM in new materials display section being inspected by C. J. Peoples, director of the procurement division and Louis A. Simon, supervising architect.

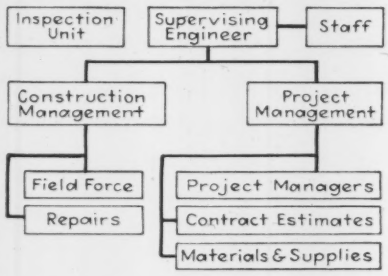
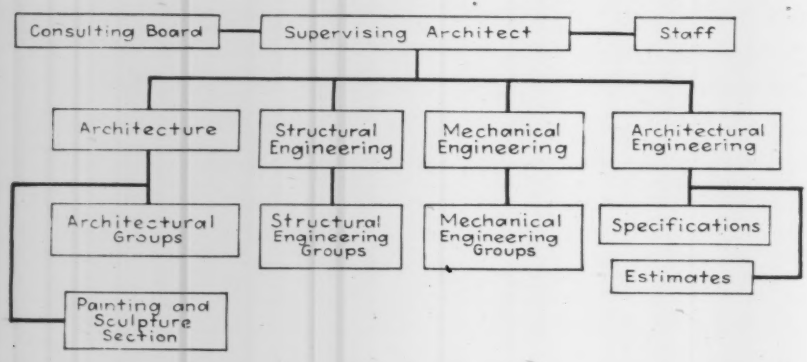


FIG. 2—ENGINEERING organization of Treasury Department, procurement division.

FIG. 3—ORGANIZATION of supervising architects' office.



Design and construction separated

In the Washington office design has been split away from construction. From the time the contract is awarded it is Mr. Melick's job to see that it is carried out properly and the contractor paid off.

C. H. Branscombe, head of the construction management section, is in immediate charge of the field forces and all the actual work of construction. Award of contracts is made by a board of six made up of: E. R. Whitman, chairman and special assistant to the director of procurement; Neal A. Melick, supervising engineer; P. I. Balch, administrative assistant to the supervising architect; J. H. Schaefer, office manager, procurement division, N. S. Thompson, superintendent of mechanical engineering; and William K. Laws, chief counsel, procurement division.

Inspection unit formed

A newly created inspection unit is manned with eleven engineers, each chosen for special work. One, for instance, is a specialist in foundation work. One deals exclusively with labor troubles. Still another is a structural designer. All of the eleven are experienced construction men. They rove around the country and are encouraged to say what they think and to make sure that everyone concerned gets a fair deal. Fig. 2 shows the engineernig division organization set up.

Architecture separate

Completely detached, under the new set up, is the architectural organization. It is under the direction of L. A. Simon, supervising architect, who has equal

rank with the supervising engineer. The architectural organization chart is shown in Fig. 3.

The consulting board, an advisory committee on architectural design, is made up of the following widely known architect: Charles Z. Klauder, chairman, Philadelphia; Aymar Embury II, New York; Philip Maher, Chicago; and Robert Shepley, Boston. Mr. Simon also sits as a member of this board.

Under Mr. Simon, W. G. Noll serves as superintendent of architecture. T. C. Brooks is superintendent of structural engineering. The superintendent of mechanical engineering is N. S. Thompson, while J. W. Ginder superintends the architectural engineering work.

This architectural organization, one of the largest of its kind, designs and completes working drawings and specifications for all federal post offices, court houses, Public Health Service hospitals and quarantine stations, as well as work for other departments. It also supervises the preparation of working drawings and specifications under contract by private architects and performs all other necessary work prior to the award of construction contracts.

Building materials display

In connection with the current public building program a score of rooms in the building occupied by the procurement division have been assigned to the various leading materials associations to exhibit their products, showing the ultimate results which can be obtained in the design of federal buildings. For this purpose these associations have expended over $100,000 under architectural guidance, to make their displays into an artistic exhibition of high merit that will be reflected in an advanced type of architecture and use of materials throughout the nation.

The new developments in glass and synthetic materials find beautiful expression here. Quarry products are represented by samples of granite, limestone, sandstone, and marbles. Clays show their wares in terra cotta of many colors and designs, both for exterior and interior use. Brick and tile from all parts of the nation are found in hundreds of samples.

Ores find their place in the decorative and utilitarian use of steel, aluminum, bronze, and as alloys. Woods from all parts of the country with various stains and finishes are laid in different patterns.

This extensive exhibit is open to architects, contractors or to those who are contemplating building. It is claimed that it is a more extensive exhibit of building materials in finished form than ever before has been assembled.

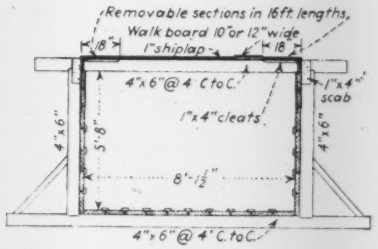
Ice Prevention Decreases Flume Outages

Despite temperatures of 40 deg. below zero, water supply to Canadian power plant is maintained by covering flume and keeping pond level above intake

By E. E. Carpenter
Consulting Engineer
British Columbia Electric Railway Co., Ltd.
Vancouver, B. C.

WINTER operating conditions on a 3-mi. wood flume serving the Barriere hydro-electric plant in British Columbia have been greatly improved by relatively simple expedients. The winter operating record has been so changed that the output of the steam standby plant has been reduced from an average of 15.6 to 1.1 per cent of the total power output of the system. This improvement has been accomplished despite the fact that winter temperatures have been much lower since the changes were effected than before. The winter of 1935-1936 was particularly severe; except for the last two days of February, 1936, the temperature remained below freezing all month and sometimes maximum temperatures were as low as 12 deg. below zero; for 23 days of the month minimum temperatures ranged from zero to 40 deg. below. Nevertheless, the flume continued to function continuously throughout this period, a record which is believed to be the result of modification of the original design.

The Barriere plant serves the city of Kamloops, B. C., with the aid of a steam generating plant located at load center. The hydro plant utilizes the water of Barriere River, a tributary of the North Thompson River. Essential features of



WOOD FLUME showing the protective cover which put a stop to low temperature outages at a British Columbia hydro plant.

the system are a low diversion dam of the log crib type, a timber flume 17,700 ft. long (with an inside section 8 ft. 1½ in. wide by 5 ft. 8 in. high), and two 42-in. wood-stave penstocks 380 ft. long, which deliver under a head of 190 ft. to two 750-kva. generating units.

Only limited pondage is afforded by the diversion dam, and there is practically no forebay capacity at the head of the penstocks. The flume gradient is 1 in 1,000 and the calculated velocity at peak load is about 4.75 ft. per sec. From the powerhouse a transmission line 45 mi. long carries the power to a substation in the city of Kamloops, where the energy is used for general light and power service.

The plant, built in 1915 by the city of Kamloops, was operated as a municipal utility until 1930, when the entire system and its properties were purchased by the British Columbia Electric Railway Co., Ltd. After this transfer of ownership an investigation of all conditions surrounding operation revealed that for six years prior to 1930 there had been excessive cost for steam-generated power made necessary by flume outages. The conditions during this period and the causes of standby operation are shown in Table I. In other words, despite the fact that there was no lack of water at the point of diversion, only 84.4 per cent of the power output was hydro, while the remaining 15.6 per cent was supplied by steam generation.

The causes of this heavy demand on the standby plant were found to be, in the order of their importance, ice conditions, flume maintenance, flume breaks, moss in flume, limitations of flume-carrying capacity due to poor condition of structure, transmission line and generating equipment outage and lack of regulation at diversion. Percentages under these classifications are shown in Table I.

After the general survey of operating conditions the power company decided (1) to cover the flume, thereby alleviating ice conditions; (2) to build a second storage reservoir in the upper reaches of the river to improve winter regulation at the flume diversion point and to maintain a more constant pond level, thus avoiding the frequent breaking up of the ice cover and the loss of its insulating effect on the water drawn into the flume; (3) to raise the flashboards in the wasteway of the diversion dam 2½ to 5 ft. during the winter season; and (4) to make gradual but continual improvement in the standard of maintenance in the flume structure itself.

By way of trying out these measures an experimental section of the flume ½ mi. long was covered in 1931 with 1-in. shiplap. This cover was merely laid

TABLE I—STEAM POWER REQUIRED BY REASON OF HYDRO OUTAGES

(Headings show cause of outage; period covered, 1926 to 1930 inclusive)

	Ice	Flume Maintenance	Flume Breaks	Moss	Regulation	Line and Plant Outages	Flume Capacity	Total
Five year total, kw.-hr.	1,951,535	1,460,130	785,150	239,180	26,400	81,420	268,290	4,812,125
Five year mean, kw.-hr.	390,307	292,026	157,030	47,836	5,280	16,285	53,658	962,425
Per cent of steam	40.6	30.3	16.3	4.9	0.6	1.7	5.6	100
Per cent of total (hydro and steam)	6.4	4.7	2.5	0.8	.....	0.3	0.9	15.6

TABLE II—OPERATING RECORD, 1926 TO 1935 INCLUSIVE, HYDRO AND STEAM PLANTS

	Hydro	Steam	Total	Steam Power (kw.-hr.) Because of Ice
Total kw.-hr. for six years, 1926-1931 incl.*	32,556,808	4,830,710	37,387,518	1,954,805
Mean kw.-hr. for six years, 1926-1931 incl.*	5,426,135	805,118	6,231,253	325,801
Per cent of total	87.1	12.9	100	5.2
Total kw.-hr. for four years, 1932-1935 incl.**	27,201,177	299,590	27,500,767	217,630
Mean kw.-hr. for four years, 1932-1935 incl.**	6,800,294	74,897	6,875,192	54,407
Per cent of total	98.9	1.1	100	0.8

*Minimum temperatures in this period ranged from – 6 deg. F. to – 28 deg. F.
**Minimum temperatures in this period ranged from – 14 deg. F. to – 40 deg. F.

on the top of the flume, but it completely closed the flume box. Observations of this section during the ensuing winter indicated that the cover would be of essential value in correcting ice troubles. Accordingly, during the summer and fall of 1932 all four of the improvements mentioned were made.

Since the four changes in original design were made there has been a four-year operating period in which to observe results. The remarkably favorable showing is indicated in Table II, which shows that the percentage of steam power has been reduced from 12.9 to 1.1 and the corrseponding percentage attributable to ice troubles has been reduced from 5.2 to 0.8.

TABLE III—COSTS OF IMPROVEMENTS TO SYSTEM

North Barriere storage dam, log crib with rockfill and spillway	$26,900
Covering flume with 1-in. shiplap and raising flashboards in spillway	5,500
Constructing 2,200 ft. bypass flume	22,100
	$54,500

The costs of the changes which accomplished this result are given in Table III. The Barriere bypass mentioned in this tabulation is not strictly chargeable to improvement because it includes the rebuilding of a section of flume washed out in 19[illegible] and replaced at that time with a 66-in. wood-stave inverted siphon.

After ice troubles in the flume had been remedied by an effective wood cover it was found that the siphon was affected by low temperatures which the covered flume would withstand. Hence, it became advisable to rebuild the so-called bypass flume. This was done in 1934, and since then the siphon has not been used during the winter. As the cost of steam-generated power in Kamloops is about 2¼c. per kw.hr. it is apparent that substantial savings have been made.

In developing the revised design the writer acknowledges the valuable co-operation and assistance of C. E. Blee, principal assistant engineer; F. H. Hatch, constructing engineer, and C. North, manger of the Kamloops division, British Columbia Electric Railway Co., Ltd.

Supreme Court Enjoins Wasteful Water Use

RECOGNIZED rights of a state to a specified share in the water of an interstate stream are upheld and enforced by the decision of the U. S. Supreme Court on June 1 in a complaint of *Wyoming vs. Colorado* growing out of the famous Wyoming-Colorado water litigation of some years ago. In the earlier decision the respective water claims of appropriators in the two states of the flow of the Laramie River, tributary of the North Platte, were decided on the basis of priority; prior appropriators in Wyoming were held to have rights superior to those of subsequent appropriators in Colorado. The decision was based on the doctrine that, since both states follow the appropriation principle in their own water adjudication, the same principle is controlling in their relations to each other.

Subsequent to that decision various diversions were made in Colorado, with the consent of the state authorities, that violated the decreed division of rights. The case decided on June 1 was brought by Wyoming to enjoin these diversions.

The decision recognizes the right of Colorado appropriators to transfer, exchange or sell water rights as between themselves, so long as the total quantity decreed to Colorado is not exceeded and provided the exchange is permitted and recognized by the state authorities. The court says of its prior decision that "The thing which the decree recognizes and confirms is 'the right of the state of Colorado or of anyone recognized by her as duly entitled thereto to divert and take' the water included in the designated appropriations."

The decision introduces an important new doctrine in respect to wasteful use of water. The earlier decree fixed a particular diversion at 4,250 acre-ft. per annum for the irrigation of 4,250 acres of native hay meadows, but the actual diversions in recent years have ranged from 36,000 to 62,000 acre-ft. per year, it was complained. Colorado's defense was that return flow reduced the actual consumptive use to the amount fixed in the decree. The court says:

> "Water is being applied to the native-hay meadows by a process of continuous flooding whereby 10 or more acre-feet are put on each acre during the irrigating season of 50 or 60 days. That this is a distinctly wasteful process is obvious. It is true that when water is so applied a considerable portion ultimately finds its way back into the stream . . . But it is also true that a material percentage of the water is lost by evaporation and other nautral processes and that there is no way of determining with even approximate certainty how much of the water returns to the stream. Colorado insists that the decree, in fixing the measure of these meadowland appropriations, refers to the amount of water consumptively used and not to the amount taken from the stream into the ditches leading to the place of use. The thing dealt with by the decree is described therein as the right to 'divert and take' from the stream and its tributaries a designated amount of water. We think these words refer to the water taken from the stream at the point of diversion, and not to the variable and uncertain part of it that is consumptively used. As it is plainly shown that diversions are being made under these meadowland appropriations in quantities largely in excess of the amount fixed in the decree, we think an injunction should issue forbidding further departures from the decree in this regard."

Wyoming also complained that its representatives were not permitted to measure water at the points of diversion in Colorado. The court says that the evidence "tends to show a need for improving the means and methods of measuring the diversions, for keeping accurate and complete records thereof, and for according to the representatives of Wyoming full access to both the measuring devices and the records. . . . While the problem of measuring and recording the diversions is a difficult one, we entertain the hope that the two states will by cooperative efforts accomplish a satisfactory solution of it. . . . Wyoming will be given leave to appeal later on for an appropriate order respecting the measurement and recording of all diversions in the event the two states are unable to agree."

California's Friant Project

Congress having provided the money, the southern part of the great Central Valley project to save the San Joaquin Valley will soon be under construction—Friant dam is the principal element.

WITH the $16,750,000 appropriated by Congress a few weeks ago, Friant Dam and the two large San Joaquin Valley canals that go with it, constituting a major unit in California's Central Valley project, are to be put under construction as quickly as surveys and plans can be completed. The U. S. Bureau of Reclamation has more than 200 men on field survey work on the project, and the bureau's Denver office is rushing design work.

Part of Central Valley project

The Friant unit is the first part of the comprehensive Central Valley project, to be built because the southerly portion of the San Joaquin Valley is suffering from a serious deficiency in the water supply, which already has forced the abandonment of many thousands of acres of orchards and farms. As planned by state authorities, Friant Dam was estimated to cost $14,000,000; just what the cost will be under the plans to be drawn by the Bureau of Reclamation has not been announced.

Field work has concentrated on those features whose construction could be started earliest. The work done since the bureau has taken over supervision is an extension of work previously done by the state. Earlier investigations made by the state were for the purpose of developing a project plan and for determining costs; for the general plan see *ENR* May 18, 1933, p. 619; July 19, 1934, p. 85; Oct. 17, 1935, p. 552, and March 12, 1936, p. 394. Work done under supervision of the Bureau of Reclamation includes investigations and surveys for construction.

Friant dam site

The bureau's parties had surveyed 6,300 acres up to the first of June including the dam site, gravel pits and camp sites. Topographical maps covering these areas have been finished. Work on the dam foundations has included putting down three 36-in. Calyx drill holes totaling 164 ft. in depth and four diamond drill holes with a total length of 863 ft. Favorable conditions in the rock (reported to be gneiss and schist) are said to be indicated in all of the holes put down thus far. In addition to the drilling, contract has been awarded for two 5x7 ft. exploration tunnels. One of these is being driven into the abutment on each side of the river. One of these tunnels is just starting, the other has been driven in about 50 ft.

In searching for suitable aggregate deposits, six tracts of land have been examined. The most promising containing material suitable for construction purposes, is located about 2 mi. downstream from the dam site. At this location the overburden is about 6 ft. deep and the gravel deposit averages about 14 ft. in depth over a 145-acre area. The quantity of aggregate is reported to be ample for all requirements at Friant Dam.

Two main canals

From Friant Dam two main canals are to extend north and south respectively, both following along the east side of the San Joaquin Valley. The Madera Canal, to the north, will have a total length of 35 to 40 miles. The Friant-Kern Canal, extending south, will be about 157 miles long, terminating at Kern River. Survey work on both these canals is now under way on the basis of a capacity of 3,500 sec.-ft. at point of diversion on the Friant-Kern Canal and 1,500 sec.-ft. at diversion point in the Madera Canal. The method of procedure is to run preliminary lines to develop general information about the most likely route and to follow with more exact location studies. Thus far final location surveys have been completed on 10 miles of the Madera Canal and 17 miles of the Friant-Kern Canal.

As soon as final location has been made, right-of-way agents begin their field work. When their findings are reported, the appraisers take the information compiled as a basis for appraisals. Thus far a portion of the canals on which final location has been made, both to the north and south of the dam site, has been appraised.

As rapidly as field data are assembled they are forwarded to the bureau's Denver office, where final designs are being prepared. All field work is being pushed to completion as rapidly as required to permit the issuance of specifications and advertisement of construction contracts. The indications are that contracts for construction on the Friant division will be advertised in the late summer or early fall.

The project is now in the hands of the United States Bureau of Reclamation, John C. Page, acting commissioner, Washington, D. C.; R. F. Walter, chief engineer, Denver, Colo. The field work in California is under the direction of Walker R. Young, construction engineer, Sacramento, Calif. The present tentative schedule for calls for bids and awards is as follows:

TENTATIVE SCHEDULE OF WORK ON THE CENTRAL VALLEY PROJECT

Feature	Cost	Specifications To Be Issued	Contract Letting
San Joaquin Division			
Friant Dam	$15,000,000	July 10, 1936	Aug. 25, 1936
Friant-Kern Canal:			
Sta. 0—Sta. 30	1,500,000	July 15, 1936	Aug. 25, 1936
Sta. 312—Sta. 780	1,850,000	Aug. 15, 1936	Sept. 25, 1936
Dry Creek Siphon	225,000	Aug. 15, 1936	Sept. 25, 1936
Sta. 780 on	2,000,000	Oct. 1, 1936	Nov. 10, 1936
Madera Canal:			
Sta. 0—Sta. 380	1,000,000	Aug. 1, 1936	Sept. 10, 1936
Sta. 380—Sta. 704	1,500,000	Sept. 15, 1936	Oct. 25, 1936
Sta. 704 on	1,000,000	Oct. 1, 1936	Nov. 10, 1936
3 Siphons	150,000	Sept. 1, 1936	Oct. 10, 1936
Contra Costa Division			
Contra Costa Canal:			
Sta. 0—Sta. 300	$500,000	Aug. 15, 1936	Sept. 25, 1936
Sta. 300 on	1,000,000	Oct. 1, 1936	Nov. 10, 1936
Kennett Division			
Dam foundation investigations (by contract)	$125,000	June, 1936	July 20, 1936
Dam foundation investigations (by force account)	50,000		
Kennett Dam 450-ft. high	117,000,000	Probably fall of 1937	
Kennett Dam 525 ft. high	130,000,000		
Kennett Dam. Excv.		Oct. 1, 1936	Nov. 15, 1936
R. R. relocation to Mile 272	7,000,000	Sept. 15, 1936	Nov. 1, 1936
Highway relocation	2,000,000	Sept. 15, 1936	Nov. 15, 1936
Additional railway grading	6,000,000	Nov. 1, 1936	Dec. 15, 1936
R. R. and right of way surveys	100,000		

Designations Changed for Hollow Masonry Units

THE ABANDONMENT of the use of values of water absorption as designations for the various classes of structural clay tile has been voted by the American Society for Testing Materials committee on hollow masonry building units. For load-bearing tile the class formerly designated as 5-16 will now be designated as LBX and that formerly as 16-25, as LB. The intended use of these two classes has been defined in terms which are believed to be more useful to the builder. The use of tile classed as LBX is not restricted, whereas those classed as LB are intended for use only where not exposed to severe frost action.

Welding Builds a Factory

All nine buildings of the new Electro-Motive Corp. plant involving 2,600 tons of steel are completely welded—Features include girders to carry 200-ton all-welded crane.

THE FIRST large industrial plant to be built entirely of welded construction went into production in April at La Grange, Ill., making diesel locomotives for the new high speed trains and other railroad services. Owned by the Electro-Motive Corp., a General Motors subsidiary, the new plant involving 2,600 tons of steel represents the largest structural welding job to be undertaken since the depression, and is among the largest on record. The framing of the main erection shop includes some notable plate girders that carry a 200-ton all-welded crane, the largest yet operated on a welded structure. The design of these girders and of the crane and the make-up of the trusses and other elements of the frame give the job a prominent place in the field of welded construction.

FIG. 1—MODERN as its product—diesel locomotives—this new plant on Illinois farmland is entirely of welded construction. Private water supply, sewage treatment and power plant make it self-sufficient.

The plant, as initially built in the fast time of nine months, comprises a group of nine buildings covering about 3½ acres and including a three-story office building and a boiler house. The manufacturing facilities in the other seven buildings represent one-quarter of the ultimate layout, which will be progressively developed in quarters, as business dictates. The main building 550x170 ft.—houses the erection shop and the machine shop. It is enclosed in 57,000 sq.ft. of steel sash continuous at the corners. The main erection shop has a clear span of 104 ft. with 49 ft. clearance under the roof trusses. It consists of 24 locomotive construction bays, most of which are served by tracks laid tranversely in the aisle. The individual bays have been designed for specific steps in locomotive construction and are closely related in function to adjacent facilities for heat treating, sand blasting, painting, and warehousing, which are housed in individual structures that open directly into the main erection aisle on the east.

Adjoining the erection shop as an aisle on the west is the machine shop with a clear span of 64 ft. and a length, as in the main aisle, of over 500 ft. Transverse monitors provide for permanent lighting and ventilation in this part of the plant, and the largest section of steel sash ever erected comprises its 550 ft. west wall. The office building, a modern three-story air-conditioned structure, was described in *Engineering News-Record*, March 19, 1936.

Private water supply and sewage plant

Since the 74-acre site is literally out in the country, sewage and water supply facilities had to be provided. These were made adequate for the ultimate plant, and the boiler installation which is used for heating can be adapted to meet future demand. The water supply system consists of a 1,600-ft. well, and furnishes water at a rate of 310 gal. per min. to a 200,000 gal. reservoir 72 ft. square. Sewage runs by gravity to a sump in the base of the boiler house stack from where it is pumped to the sewage disposal plant. This plant consists of an Imhoff tank, a dosing chamber, slow sand filters and a sludge drying bed. The filters discharge into a nearby storm drain.

Power for crane operation is supplied by diesel engines on test connected to an electric generator. Two engines which will be on test at all times will be adequate to meet the power requirements, but in addition the current generated by locomotive testing can also be made available. The test room is at the north end of the building and because of the necessity for changing the engines on test at frequent intervals, this section has been fitted with a removable roof so that it can be served by the cranes in the machine shop aisle.

The plans for increasing the capacity of the plant were quite definitely worked out. Thus the first expansion would be by doubling the initial length of the present main shop. In this way the 200-ton crane, a 40-ton crane, and a 30-ton crane in the main erection aisle and the two 20-ton cranes in the machine shop would be available for service over an area double that of the present structure. Further expansion would be alongside the building to the west and would entail removing the existing exterior wall of steel sash. In Fig. 1, taken looking west, this wall is on the far side of the building. Column footings in this wall will accommodate another crane column, and the building columns will support the roof of the extension.

In spite of its many special and modern facilities referred to above and covered more fully in the first two of the articles in the series on modern industrial buildings (*ENR*, March 5 and 12, 1936) the most significant characteristic of the plant from a technical standpoint is its all-welded framework. A major part of the welding was done in the structural shop of the contractor, located in Cleveland. Thus, of the 50,000 ft. (7½ tons) of electrode used, only 17 per cent was applied in the field. This large amount

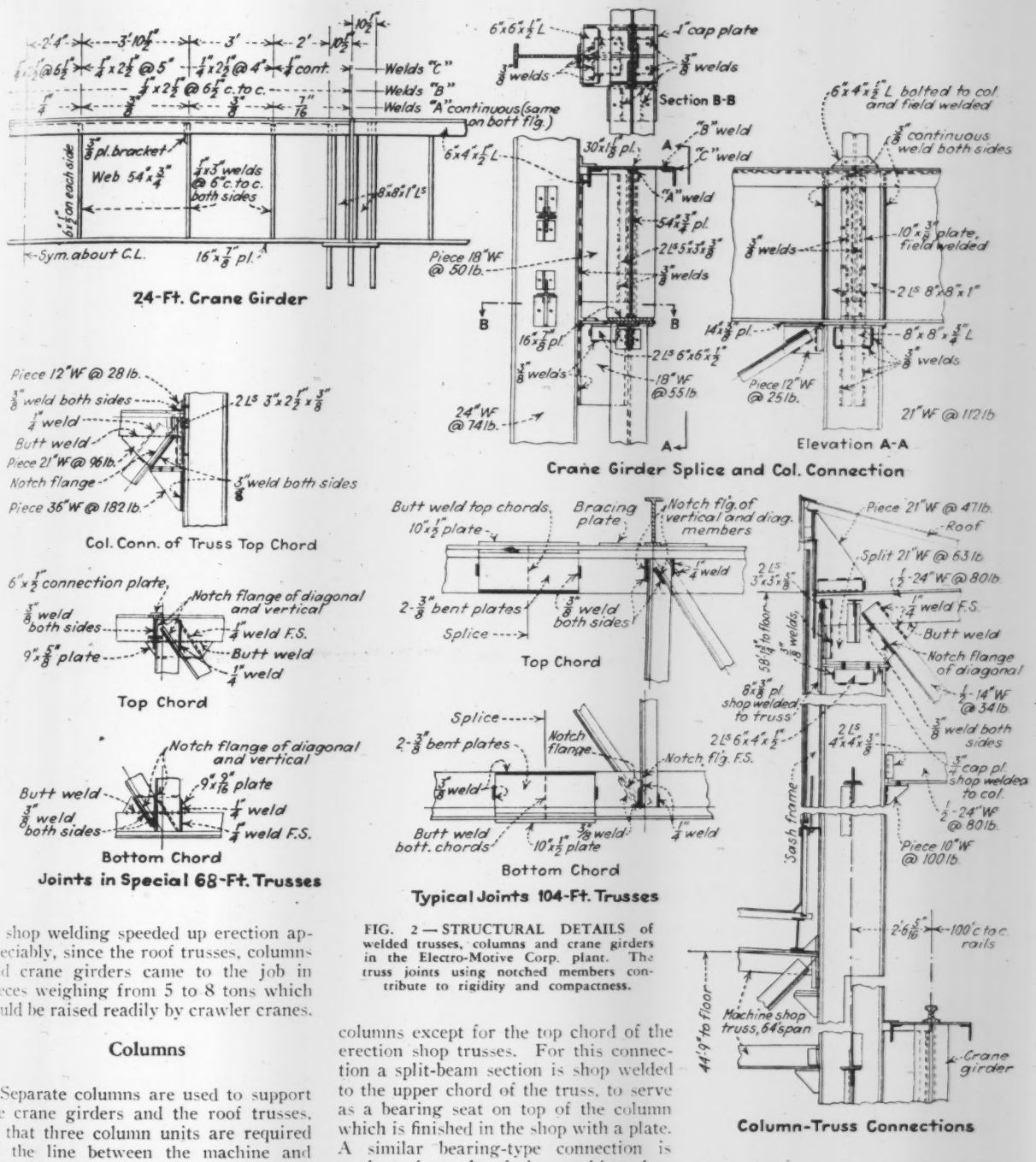


FIG. 2 — STRUCTURAL DETAILS of welded trusses, columns and crane girders in the Electro-Motive Corp. plant. The truss joints using notched members contribute to rigidity and compactness.

of shop welding speeded up erection appreciably, since the roof trusses, columns and crane girders came to the job in pieces weighing from 5 to 8 tons which could be raised readily by crawler cranes.

Columns

Separate columns are used to support the crane girders and the roof trusses, so that three column units are required on the line between the machine and erection shop aisles. The building column, a 24-in. wide-flanged 74-lb. section, is 65-ft. long, the machine shop column, a 12-in. 32-lb. section is 25-ft. long and the erection shop column, a 21-in. 112-lb. section, is 33 ft. long. The columns are tied together by stub beam sections welded on 3 ft. centers vertically as shown in Fig. 5. This same view shows the simple triple-column base detail developed with channels, plates and split-beam sections.

Truss connections to the building columns are equally simple, consisting of split-beam brackets shop welded to the columns except for the top chord of the erection shop trusses. For this connection a split-beam section is shop welded to the upper chord of the truss, to serve as a bearing seat on top of the column which is finished in the shop with a plate. A similar bearing-type connection is used at the ends of the machine shop trusses that rest on the west wall columns.

Trusses

The extensive use of the split beam as noted for the details on the building columns is extended to the trusses, all members of which are of this section. Thus in the machine shop trusses which have a 68 ft. span, center to center of columns, the top and bottom chords are tees made from one-half of an 18-in. 47-lb. section. The verticals are split 8-in. sections and the diagonals split 6-in. I's. Likewise in the erection shop trusses, each of which weighs 7 tons and has a span of 104 ft., the chords are one-half of a 24-in. 80-lb. wide flange section while the web members are split from sections varying in depth from 12 to 7 in. All longitudinal bracing frames have a similar makeup.

The 104-ft. trusses vary in depth from 9 ft. 1¾ in. at the ends to 11 ft. 4 in. at the center. The 68-ft. trusses are 10 ft. 6 in. deep at the west wall and 7 ft. 9 in. deep at their inner end. The trusses are spaced 24 ft. apart.

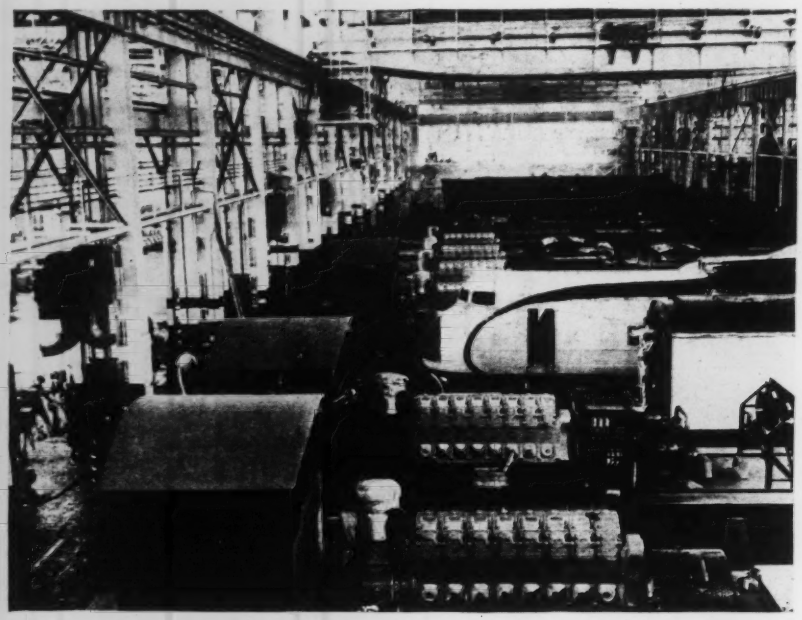


FIG. 3—DIESEL LOCOMOTIVES on the production line are moved into the various construction bays by the 200-ton overhead crane which spans 100 ft. across the erection aisle of the main building. Machine shop aisle is at the left.

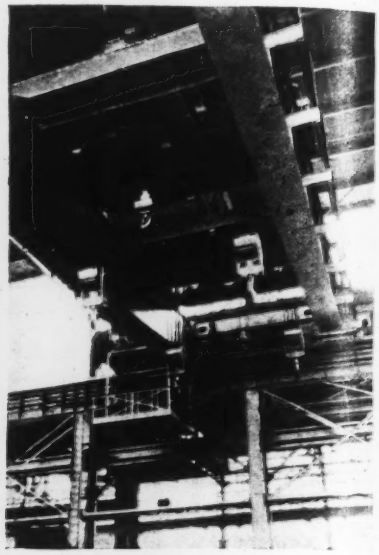


FIG. 4—LARGEST WELDED CRANE yet built carries four 50-ton hooks and two 15-ton auxiliaries. The twin girders have a span of 100 ft. Note the building girder upon which this huge mechanism operates.

With the exception of two locations, all the 104-ft. span trusses are alike. One of these locations is at the expansion joint at the center of the building. Here double trusses 3 ft. 3 in. on centers are used, each of which is of lighter construction than the standard truss. Two other special trusses span the erection shop, also near the center of the building. These trusses were installed to facilitate erection and future servicing of the 200-ton crane. A 36-in. 150-lb. girder beam 24 ft. long is framed between the two trusses, to provide a support for the necessary blocks and falls. The top chords of these heavy trusses are split 24-in. 100-lb. sections, and the other members are also heavier than those in the standard truss. The maximum stress in these top chords was calculated to be 231,600 lb. Under a load of 52 tons, the largest crane erection piece, the deflection of these trusses was only $\frac{3}{4}$ in., attesting to their rigidity.

The heaviest trusses in the building span the machine shop at the south end, adjacent to the office building (Fig. 1). Designed to support a future drafting room, these two trusses have top chords consisting of one-half of a 30-in. 124-in. section designed for a maximum stress of 263,000 lb.

No gusset plates are used in the trusses, and the joints were made compact and rigid by the interesting expedient of notching the flanges of the web members to fit over the stems of the chord sections. This arrangement also placed all T-section stems at a joint on the truss center line and aided in reducing weld eccentricity.

Three cranes of 200-, 40- and 30-ton capacity respectively operate in the erection shop. The machine shop is served by two 20-ton cranes. The 200-ton crane is the largest ever operated on a welded structure, and the crane girders are, therefore, of more than usual interest. They carry exceptionally heavy crane rails weighing 175-lb. per yd. These girders, which extend the full 550 ft. length of the erection shop, are designed for 24 ft. spans except in one bay where 48-ft. is required to furnish an entrance for a gantry crane. Built up entirely of plates, except for flange angles and angle stiffeners over the columns, the girders, weighing about 5 tons for each 24 ft. span, were completely welded in the shop.

The webs of the 24 ft. girders are 54x$\frac{3}{4}$-in. plates and the bottom flange is a 16x$\frac{3}{4}$-in. plate. The top flange is composed of a 30x1$\frac{1}{8}$-in. plate with a 6x4x$\frac{1}{2}$-in. angle along each edge. Stiffeners consists of 7x$\frac{1}{2}$-in. plates. At the ends of the girders, over the columns, 8x8x1-in. angles are used for stiffeners. Splice plates set between the legs of these angles are 10x$\frac{3}{8}$-in. Similar makeup characterizes the 48-ft. girder in which the main elements are a 72x1-in. web, an 18x1-in. bottom plate, a 35x1-in. top plate and two 6x4x$\frac{1}{2}$-in. angles.

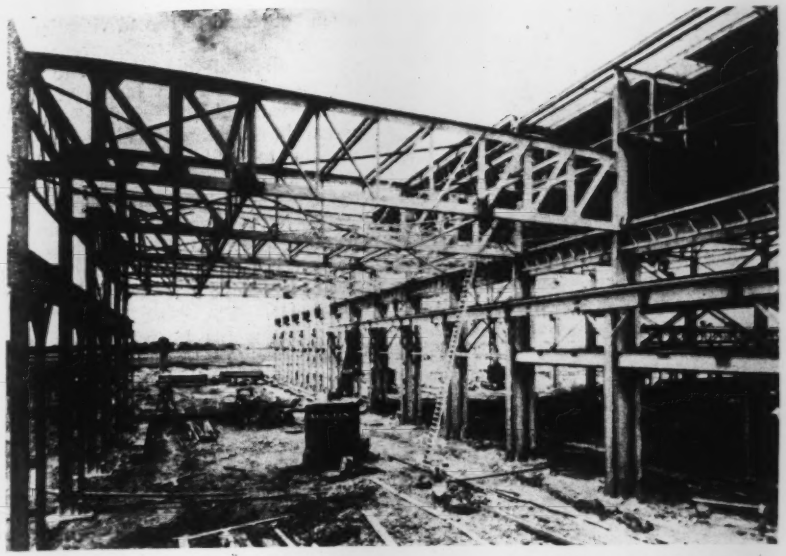
Because of the current interest in welded structures subject to dynamic loads, the loading conditions for these girders are interesting. The wheel load of the 200-ton crane fully loaded is 141 kips, and of the 40-ton crane is 85.1 kips. For maximum vertical moment on the 24-ft. girders, two wheels (one truck) of the 200-ton crane and one wheel (one truck) of the 40-ton crane were considered to be in the span, and 15 per cent impact was used. The resulting moment is 22,095,000 in.lb. For end shear, both trucks (four wheels) of the 200-ton crane were placed in the bay, with one wheel just inside the support. An impact of 25 per cent was used giving wheel loads of 176.5 kips. The resulting shear is 379,800 lb. Maximum column reactions are 486,000 lb. vertical and 25,830 lb. horizontal.

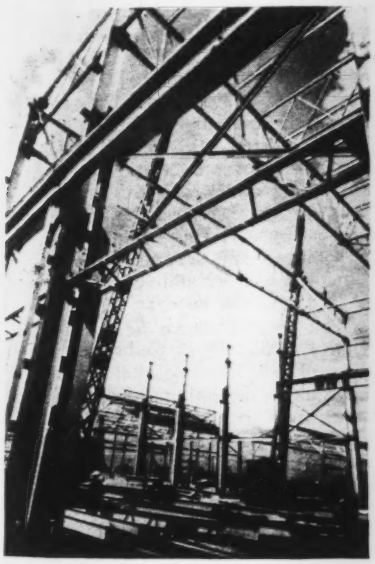
For the 48 ft. spans, both the 200- and the 40-ton cranes are considered as loads giving a maximum moment of 41,840,000 in.lb. and an end shear of 328,700 lb.

Welding design and procedure

The welding design for all of the connections was based upon usual unit stresses for static loads; in the case of the crane girders, which are subjected to moving loads, from 15 to 25 per cent impact was added to the maximum static load, and no increase in unit stress was used. Joint proportioning was such as to keep all but a very few welds down to $\frac{3}{8}$-in. size and these could be made with one pass of the electrode. Covered electrodes of $\frac{1}{4}$ and $\frac{5}{16}$ in. size were used. All welding was by hand, with the members in the shop assembled in jigs by clamps. No overhead welding was permitted either in the shop or field. The shop work also required considerable flame cutting especially in notching the ends of the truss members, to permit compact joints. Machine operated torches were used in order to achieve smooth edges and a reasonably accurate width of notch.

The most difficult welding occurred in the shop fabrication of the crane girders, in which it was necessary to avoid shrinkage stresses and distortion in the flange plates. A step-back procedure of laying the bead between the web and flange was adopted and carried out by a





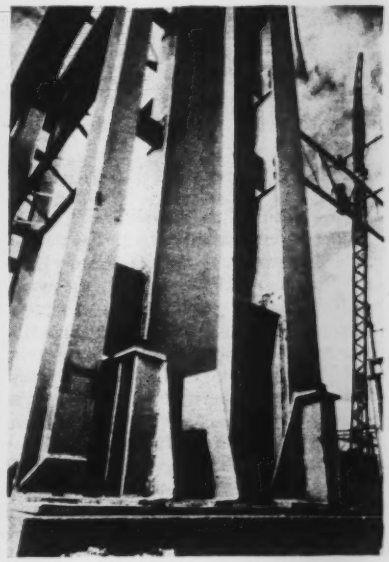


FIG. 5—WELDED FRAMEWORK being erected. Top: Trusses spanning the machine shop aisle. Bottom left: Crawler cranes setting 104-ft. span roof trusses over the erection aisle. Bottom right: Base detail of a three-column unit.

welder starting at each end of the girder and working toward the center. Each welder placed 18 in. of weld at a time always working backwards from the far end of the 18-in. increment.

The largest welded crane

The 200-ton crane, itself weighing 205 tons, is the largest all-welded crane yet built. It is equipped with four 50-ton hooks and has a one-piece all-welded trolley frame and one-piece all-welded end trucks, with all-welded box girders and bearings. All the gears and pinions are enclosed in welded oil-tight cases.

The girders of the crane, spanning 100-ft. across the erection shop, are fabricated from plates varying in thickness from $\frac{7}{8}$ to $1\frac{1}{8}$ in. Each girder weighs about 40 tons and required three flat cars to accommodate it during shipment to the plant. The trolleys were shipped in cars with specially constructed wells, in order to negotiate railroad clearances.

Although the Cleveland Crane & Engineering Co., designers of the crane, had built several hundred welded box girders, some of over 100 ft. span, the two required for the 200-ton Electro-Motive Corp. crane are the largest yet attempted. At the same time they are the strongest per pound of material that have ever been designed and show a saving in weight of 15 per cent over a riveted design.

After taking into consideration all factors, including impact of moving loads and stresses set up by sudden stops of the bridge, these large girders were designed with a maximum stress of 12,000 lb. in tension and 10,000 lb. in compression. Fillet welds were provided throughout. The diaphragms in the girders were spaced close together and welded to the inside of the top cover plate, as well as to the two web plates. Such construction shows up to real advantage with sudden stoppage of the bridge which subjects the girders to a twisting action.

One of the problems with girders of this length is to keep them straight and of correct 1-in. camber during the welding. To get this result it is absolutely essential to balance the heat, and this was accomplished by welding each side of the girder simultaneously with the same heat and at the same rate of speed. Much of this welding was done with an automatic welding machine equipped with two welding heads which travel together on opposite sides of the girder, welding both fillets at one time.

In erecting the 200-ton crane a temporary track was laid into the building extending as far as the two extra-heavy welded roof trusses. The end trucks which carry the crane were set into place on the crane rails. Then, in order to raise the girders into place about 40 ft. above the floor level, a special clamp was fitted to each which afforded the grip necessary to enable two locomotive cranes, one on each side, to hoist the load. The same procedure permitted the placing of the two trolleys on the crane girders.

The plant was designed, fabricated and erected by the Austin Co., Cleveland, Ohio.

Chlorine Dosage Controlled by Automatic Residual Tester

A CONSTANT RESIDUAL chlorine is maintained regardless of the chlorine demand in the Los Angeles system by an apparatus which automatically tests the water with orthotolidin every three minutes. The dosage is then automatically increased or decreased through a mechanical motion set up by a photoglow tube measuring the residual chlorine so that residual is always uniform in amount.

The chlorine dosage varies from 1.8 to 4.5 lb. per million gallons and is usually highest following heavy storm runoffs into impounding reservoirs. The residual chlorinator not only effects a material saving in chlorine, but, what is more important, reduces chlorinous tastes and odors to a minimum while at the same time it insures adequate disinfection continuously.

Letters to the Editor

Efficient Refuse Incineration

Sir—I have read the two articles entitled "Basic Principles of Incineration," (*ENR*, May 14, p. 687 and May 21, p. 740, 1936), written by Edward D. Very, with much interest. It is gratifying to see articles on this subject written without bias and containing so much valuable information, valuable not only to engineers, but also to laymen connected somehow with municipal administration or public works.

The writer has had occasion to design and build refuse disposal plants, both of the "garbage crematory" type and of the later "refuse destructor" types and for that reason is well acquainted with the successive steps of their development. I appreciate especially and agree heartily with what Mr. Very says about the disappearance of the so much discussed drying hearth and the increased use of forced draft, preheated air supply and maintenance of a safe temperature in the combustion chamber. These features, plus the mechanical ash and clinker grate, which is now available, constitute a modern, efficient design of refuse incinerators.

J. BORGE,
Consulting Engineer,
Santation Engineers & Constructors, Inc.
New York, N. Y.,
June 1, 1936.

Chemical Solidification In the Moscow Subway

Sir—The article in *Engineering News-Record*, April 9, 1936, on the Moscow Subway, by I. Gutmann, was very interesting, especially with regard to the chemical solidification work described in it.

In the article it states that the German firm controlling the Joosten process of chemical grouting refused to bid, as physical conditions were too unfavorable, and that the Soviet government then appointed a joint research committee headed by Rzhanitzin, and representing eight leading scientific and engineering institutes of the country, and within three years an "original" Russian process of chemical grouting was developed.

As I have been engaged in carrying out work in England with the Joosten process for several years, it was amusing to read the description of the "original" process evolved, which turns out to be nothing more or less than the Joosten process itself.

Without knowing anything of the actual facts of the case one could imagine that there may have been other considerations and not only the physical conditions that made it unattractive for the German firm. The article states that the work was carried out at a fraction of the cost of the German estimate. The cost would naturally be lower for work carried out by the Soviet themselves, as there would be no question of profits, lodging and payment for foreign experts, or payment of royalties. However, the cost of the work itself could hardly have been as low as is implied, especially if the cost of the three-year research work is added—which in capitalist countries is partly represented by royalties. The chemical must have cost something, and the labor and gear required for any injection process cannot differ largely, as nature sets the same problems to be overcome, whoever the operator may be and whatever the solidifying agent used.

H. T. B. HARDING

London, England.
May 25th, 1936.

Elevated Tanks In Earthquakes

Sir—Noting the article "Elevated Tanks Strengthened after Earthquake Hazard Survey" by H. M. Engle (*ENR* June 4, 1936, p. 807), the writer would like to recall the merits of dynamic designs and the possible dangers of static designs by referring to *ENR* of October 4, 1934, in which were described preliminary results of shaking-table research at the Massachusetts Institute of Technology.

The extensive program which Mr. Engle describes, in so far as recommending the repair or removal of tank structures which were originally poorly constructed or later neglected, aside from any earthquake considerations, is most commendable. It is surprising, however, that such serious defects could have existed without previous discovery by insurance companies or building departments, followed by needed repairs. More supervision of designs and workmanship is evidently urgently needed. Tank construction should be performed only by the most reliable contractors.

In regard to structures designed to resist earthquakes, it was to be expected that few existing tank towers would be found with designed resistance to lateral loading, other than wind, because of the previous general lack of such a requirement in this country. The 1933 quake furnished needed impetus to efforts at overcoming this danger to public welfare.

In order to obtain better data regarding the probable action of a tank tower when subjected to forced vibration, the Factory Mutual Fire Insurance Companies directed this problem to the attention of M.I.T. in January, 1934, as a practical subject for thesis work or research. Shaking-table research pertaining to building frames had been under way there for a few years. Subsequently, a senior in civil engineering started a thesis under supervision of Arthur C. Ruge, Research Associate, to determine, if possible, how the vibration stresses in a tank tower should be computed. The work was soon given greater impetus by continuous experimentation and study by Mr. Ruge, made possible by assistance from the Freeman Engineering Corporation, the Division of Industrial Cooperation of M.I.T. and manufacturers of elevated water tanks. Progress and early results were reported soon after (*ENR* Oct. 4, 1934, p. 424).

Referring to that article, Fig. 3 shows that two consecutive transient harmonic vibrations (solid curve 2T), with acceleration of 3 per cent g, and with the ground period about equal to the period of free vibration of the tank tower model, resulted in a deflection at the tank 3¼ times as great as would result due to a static horizontal load of 3 per cent of the weight of tank and contents, applied at the tank. Tests confirmed this result. Such great inaccuracy of the "static" method was surprising and worthy of consideration. Any program of repairs such as described by Mr. Engle and involving an expenditure of several hundred thousand dollars should have a sounder basis than now appears.

The results shown in the article of Oct. 4, 1934, Fig 3, and other tests indicate also the possibility that the maximum deflection of similar tank structures resulting from resonance with many consecutive similar harmonic motions at an acceleration of 10 per cent gravity might be at least $5 \times 0.10g\ 0.03g = 16$ in., if the tower would withstand such a motion. It is impossible to design a conventional tower, with the usual diagonal members, to accommodate such a large deflection without danger of collapse.

If the size of members of the tower should be designed for a horizontal static load of 10 per cent of the weight of tank and contents, or more, at the tank, as recommended by Mr. Engle, the tower would be more rigid. The maxima or high points of the curves in Fig. 3 would move to the left (resonance at shorter periods of vibration) but would drop downward only slightly. If the maxima of the curves could be moved far enough to the left, say to periods of 0.20 sec. or 0.25 sec., which is apparently below the probable range of destructive earth motions, the solution by static loading would be valid, but it is impracticable to make the usual high tower, with diagonals so rigid.

The determinations of natural periods of vibration of existing high tank towers reported by the U. S. Coast & Geodetic Survey in the January 1936 Bulletin of The Seismological Society of America show that the recommended strengthening of high towers which has been based upon the static method is ineffective in reducing their natural periods of vibration below the earth periods to be expected in destructive quakes. Taking one typical example, after strengthening the 100-ft. tower supporting the 75,000-gal. tank at the Paraffine Cos., Inc., Emeryville, Calif., by the static method (12% to 15% of the weight of tank and contents), a natural period of vibration of 1.10 sec. was measured with the tank full of water. (Condition of rods listed as "unknown." As all rods were doubtless tight after repairs, the actual period would be greater than 1.10 sec. in a violent quake during which the initial stresses would be removed from the counter rods as a result of tower deflection.) Before strengthening, it had periods of 1.55 and 1.60 secs. (Rods probably loose). It is understood that the cost of such strengthening by the static method was $2,800, or about 45% of the current cost of a standard structure of this size exclusive of foundation and not designed for lateral loads other than wind.

The measurements of natural periods of vibration of towers has also been helpful in determining approximate correction factors to be applied to various calculated periods.

The design of the 100-ft. tower and 60,000-gal. tank at the Willard Storage Battery Co., Los Angeles, a model of which was used in the shaking-table tests, was studied to determine the probable effect of stiffening. One rod broke and several rods stretched in this tower during the Mar. 10, 1933, quake. With the structure theoretically strengthened for 10 per cent of the weight of tank and contents at the tank in accordance with Mr. Engle's recommendations, the calculated deflection of the tower would be only 0.63 in. due to the static loading of 3 per cent of the weight of tank and contents at the tank used in the tests, instead of 1 in. as shown in Fig. 3 for the original structure, whereas a maximum deflection of about 4 in., well above the elastic limit, would result due to resonance. Increased rigidity of the high tower, within practical limits, would therefore not be effective with regard to resisting such resonance.

The U. S. Coast & Geodetic Survey measured, among many such determinations, natural periods of vibration of 1.41 and 1.51 sec. for the actual 60,000-gal. tank on 100-ft .tower at the Willard Storage Battery Co., Los Angeles. They also determined from the Los Angeles station seismograph record of Mar. 10, 1933, that there were 3½ consecutive similar earth waves of 1.46 sec. period at 2 per cent gravity average-acceleration. There were three consecutive similar waves of 1.71 sec. period at 1.6 per cent gravity average-acceleration. These consecutive repetitions of similar earth motions or periods indicate the likelihood of resonance in the case of some common tank towers. There were also 3½ consecutive waves of 0.60 sec. period at 2.8 per cent gravity average-acceleration; 2 of 2.01 sec. period at 1.78 per cent g acceleration; 1½ of 2.82 sec. period at 2.7 per cent g acceleration; and 2½ of 3.23 sec. period at 2.15 per cent g acceleration. Periods of about 3 sec. in Fig. 3 represent resonance with the water in the tank. There were groups of two or three consecutive waves of 2.56, 3.50, 4.70, and 5.21 sec. periods which could cause resonance with some structures, but the corresponding average accelerations were very small.

Resonance *might* not occur

The data given above indicate that a particular tower might not be damaged in a certain quake because the natural period of vibration of the tower might not be sufficiently near the period of the earth in a group of a few consecutive similar waves of moderate or high acceleration or because a single earth wave at about the critical period but of low acceleration, might be insufficient to invoke serious resonance.

The 75,000-gal. tank on 124-ft. tower, at the Proctor & Gamble factory in Long Beach, which was originally designed in 1930 for 10 per cent of the weight of tank and contents static loading at the tank, was supported on piles, 16 under each of the four concrete piers. This unusually stiff structure was not damaged by the quake of Mar. 10, 1933. Of two very similar 150,000-gal. tanks on 100-ft. towers, not designed for earthquake loading, about three blocks apart at South Gate, the one on piles with interconnected concrete foundations did not collapse, although a turnbuckle was broken and a number of rods were stretched, while the one without piles but with usual concrete footings did collapse. The tanks were reported full during the strongest shocks. The existence of poor, mobile soil at the surface where motion may be greatest, together with piles extending a considerable distance below the surface where motion may be less severe, seems to the writer a possible explanation of the lack of damage to the Proctor & Gamble tank. L. K. Nishkian, consulting engineer, brings out in *ENR* April 13, 1933, that the ability of piles to bend may relieve the supported structure from the full effects of the shocks. This result was noted in the case of buildings as well as of elevated tank towers. Also, there may be limited areas where earthquake motion is less severe than at other surface locations near-by. Future quakes may be more severe, of longer duration and more nearly in resonance with the structure, indicating the advisability of providing resistance to dynamic stresses.

The 30,000-gal. steel tank on 106-ft. tower of standard design, without additional strength to resist horizontal static forces, at the General Electric Co. in Los Angeles was not damaged by the Mar. 10, 1933, quake as determined during an expert inspection by C. K. Stiff, engineer of the Factory Mutual inspection department. The structure was built in 1925 by the Chicago Bridge & Iron Works. The buildings of the factory were considerably damaged, indicating a severe shock at this location. The full tank swayed back and forth rather violently, throwing water out of the top. Some space formed between the top of the concrete piers and the surrounding earth. The concrete piers were not on piles. None of the diagonal rods stretched or loosened. The top three panels of this tower were 12½ ft. and the lower three panels 25 ft. high. The soil is alluvium for many hundred feet, with water saturation 80 ft. below grade, a type of soil which is violently shaken by destructive quakes. This experience might logically be cited as indicating that such a structure does not need any strengthening, not even that recommended by Mr. Engle. Other tank structures, of different size but not designed statically to resist earthquakes, were damaged in this general vicinity. The corrected calculated period of free vibration of the General Electric Co. tower is 1.02 sec., which may differ sufficiently from the earth periods which occurred in groups not to have invoked resonance in this particular quake. Future severe quakes might have more critical periods and accelerations. Furthermore, there was a sufficient percentage of structures damaged by the moderately severe quake of Mar. 10, 1933 (about 60 per cent of the high independent structures at Factory Mutual plants between Long Beach and Los Angeles, but no collapses) so that the conclusion that such structures do not need more resistance to quakes does not seem safe for expected stronger and longer quakes of probably different periods and accelerations.

Summarizing, the research work so far indicates the advisability of repairing towers to resist dynamic rather than static stresses. The behavior of certain tank structures during the Mar. 10, 1933, shock can perhaps not be unquestionably explained with present knowledge, but in general the writer urges the use of data now available regarding dynamic stresses and the spending of more effort and money to increase this knowledge and less in strengthening elevated tank towers on the static basis.

H. A. SWEET
Engineer, Factory Mutual Laboratories
Boston, Mass.,
June 27, 1936

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July 16, 1936

No Funds Yet

NO LITTLE CONFUSION exists as to the status of the $300,572,300 of flood control projects covered in the Omnibus flood control bill passed by Congress. That bill *authorized* the expenditure of $50,000,000 for the first year's work, but Congress failed to *appropriate* the necessary funds. Hence no physical work can be done on the projects until after Congress meets again and appropriates the necessary funds. However, there is much preliminary planning that can be done to facilitate an early start when funds are made available, for Congress left to the President the determination of the order in which the work is to be done. Without doubt the President will choose for early financing those projects that are ready to go. In the case of projects calling for local participation this means that the local ordinances providing the needed local funds should be passed if possible before January. Here, then, is a channel through which local interests can work for projects that they wish to get under construction at an early date.

What Next in Sewage Disposal?

DURING THE LAST decade there has been a gradual emergence of sewage disposal practice from the status of an art to that of an exact science. In this period, which, among other things, witnessed the revival of chemical coagulation, there occurred important advances that included the perfection of separate sludge digestion, better control of the activated sludge process, the use of shallow mechanical filters and the introduction of vacuum sludge dewatering and incineration. Probing into the future, Dr. Willem Rudolfs, in a recent address, part of which is reported on page 84 of this issue, forecasts that we are now entering an era wherein there will be considerable emphasis on the development of physical treatment processes as well as on the perfection of chemical treatment. But he is careful to point out that it is not likely that these will quickly usurp the favor now enjoyed by biological processes because in this field, too, there is promise of further refinement leading to more effective application. With this stimulating activity from three directions—physical, chemical and biological—sewage disposal practice should remain in a vigorous state of flux, and there is every indication that we can look forward to another decade of vital development even more important than the last.

Dry Humor?

LIGHTHEARTEDLY WRITING NEW WORDS into the engineer's dictionary, the President has called a conference on "Upstream Engineering," to meet in Washington in September, so an official news release informs the world. On this occasion such widely diverse kinds of men as deans of engineering colleges, geophysicists and "sedimentationists" (whatever these may be) are to foregather, and their mission is to be the consideration of drought-preventive and flood-preventive measures. To this discussion a paper on "Basic Principles of Water Behavior" should contribute its quota, but the big splash will come with addresses on "The Comprehensive Point of View in Engineering," and "The Human Value in Upstream Engineering." It further appears that the object of the discussion is to consider how "through forestry and land management to . . . retard the journey of the raindrop to the sea." Shades of the Shelter Belt! To describe this as drought prevention is rather a bit of dry humor stirred up by the North Dakota drought, or it is badly muddled thinking. At least the ordinary mind does not at once grasp just how forestry and land management are to prevent droughts in North Dakota, or for that matter elsewhere. Climate control may be an ultimate achievement of science, but it is still too far off for conferencing. And while it is true that rivers have their source on the ridges, where forest and land conservation have a real function, sound lessons of this kind are unlikely to make headway through ridiculous sensationalism. A bit of real accomplishment supported by sensible publicity would be more to the point.

For Safe Dams

EIGHT YEARS AGO last spring, public sentiment in California was so aroused by the St. Francis Dam failure that pointed questions were asked: Whose business is it to look after the safety of dams? Are other dams safe? Sentiment was strong enough to get results. Under a state law passed in 1929 a new branch of the state engineer's office was organized, given special training, provided with consultants on special occasions, and in every way equipped for the enormous job of analyzing more than 900 dams. That work has been completed. How ably it has been handled is attested by the confidence and cooperation of the owners and by the fact that there have been no adverse court rulings. How badly the statewide check-up was needed is shown by the findings, which have been guarded rather closely and whose substance has only now become known: Not more than one-third of the dams could be pronounced satisfactory immediately, one-third required further consideration, and *one-third needed repair*. It is a shock to find so large a percentage of defects. The conditions disclosed must be embarrassing to Californians—though there is no ground for believing that other states could show a better record. If such conditions exist it is imperative that the facts be determined and squarely faced rather than suffer the consequences of not knowing them. Because California has so large a number of important dams it is logical that an example should be set by that state. Its experience suggests that a check-up would be well worth while in other states. The time to make sure of safety is before a failure occurs.

What Does a Bridge Cost?

IN STATING BRIDGE COSTS, engineers are encountering some of the same kinds of difficulties that exist in attempting to answer such questions as: How high is a dam? How tall is a building? How long is a bridge span? The difficulty lies in ill-defined basic assumptions and datum planes. What is a bridge? Until the George Washington Bridge over the Hudson River was built, the main structure and the short approaches necessary to bring the deck down to the ground were all that had to be considered. The total cost—the sum of real estate, foundations and superstructure items—was easily arrived at. But the engineers of the George Washington

Bridge recognized, almost for the first time, the bridge builder's responsibility to provide adequate approaches, with the result that the New Jersey highway department and the city of New York cooperated in building a remarkable and far-flung "gathering system" for traffic. The practice has been emulated on all recent large bridges. Is the expense of these approachs and connections part of the cost? The Port Authority carries the George Washington Bridge on its books at $56,204,730, which is its investment, but this leaves out the approach investment made by others. Last week, the Triborough Bridge was opened in New York City. Some 3 miles long itself, it boasts nearly 14 miles of approaches and connections. The bridge cost is $31,800,000. Connections provided by the city cost $10,700,000, by the Triborough Bridge Authority $17,800,000. The total expenditure is $60,300,000. The PWA loan and grant to the bridge authority comes to $44,200,000. All three of these totals have been quoted as "the cost." Obviously the true cost of the project is $60,300,000. Engineers will always be interested in the bridge cost figures too, but it is well to start thinking in terms of total cost, for we are designing and constructing bridge *projects* today, not just stream crossings.

A Gospel of Regulation

THE SERIES OF ARTICLES on regulating transport which ends in this issue deserves attentive reading. Whether agreed with or disputed in detail the articles perform a needed service in debunking regulation. In the passing years an accumulation of regulatory acts not only has piled restriction on restriction into a topheavy mass but regulation has become such a habit of thought that even its victims vie with each other in striving to have it imposed on their rivals.

Our problem in relation to transportation is not a real transport problem; it is rather one of too much regulation of transportation agencies. The thing that transport needs most today is a thorough tearing apart of the complex laws that now govern it and replacement by a far simpler legal structure. The articles that have run through the last six issues indicate this need, and show wherein our system of regulation has grown from one of simple regulation to one in which the regulatory commissions have taken over the functions of management, thus deadening the initiative of the operators. This tendency, as Prof. Worley points out, is a natural one, but it is one that should have been strongly opposed by all who wished to see our transport system developed most efficiently. That it was not opposed but was even encouraged by such legislation as the Transportation Act of 1920 is one reason why drastic changes in our laws now are needed.

But the agencies of transport have on their part an equally important task. They have departed from the old traditions of self-reliance and sought frantically for the state to assume responsibility for their misfortunes. Truly they have not been free to act for themselves, but just as truly they have not tried to win the transportation race by running but by seeking to have the judges impose handicaps on competitors. Those who vend transportation have become almost as fanatic disciples of regulation as those who live by its exercise. In making this fact plain the articles perform a second important task.

And the articles purposely go no further: they claim no Messianic qualifications. They strip regulation of its creeds and dogmas and leave it a very simple gospel. Return to this gospel is the present transportation problem and its solution calls for a revolutionary change of thought and practice.

Earthquakeproof Tank Towers

SINCE SAFETY in earthquakes should beyond doubt extend to structures of such necessary character as tank towers, the importance of the subject discussed by H. A. Sweet in a letter in this issue needs no emphasis. It appears however that up to now we lack a good deal of knowledge essential to safe design. The failures in the 1933 quake at Long Beach show that customary tower construction leads to a large proportion of complete or partial failures. Tank towers should evidently be made stronger; the question is how much stronger, whether to the point of being able to resist a horizontal load equal to a prescribed part of the tank weight, or to the point of resisting resonant oscillation. And here we enter the battleground of static against dynamic design, just as in the case of frames of buildings.

Resonance with the repetitive vibrations of the earthquake is no doubt more probable in the case of a tank tower than in the case of most buildings. If the frequencies of tower and of earthquake differ sufficiently there can be no resonance nor sufficient approach to it to cause noticeable increase of stress; in this event a static calculation for design would appear to be all that is needed. If, on the other hand, resonance occurs, how will dynamic designing help? The M.I.T. shaking-table tests, unfortunately still unpublished, indicate that resonance could break down even an abnormally strong tower, for the inherent damping of the tower is small, and it needs only a sufficient number of shock vibrations at the resonant frequency to produce a sway large enough for failure. Therefore, instead of computing the effects of resonance and trying to resist them, we should better seek to prevent resonance.

Recent earthquake discussion has been based on the data of the Long Beach quake, since no other near-to-focus records have been obtained. The well-deployed battery of strong-motion seismographs in California will in time provide more adequate material, but until then it must be assumed that earthquakes are not alike in period and that within limits almost any frequency of repetitive vibrations may be encountered. Under such a condition it would not be possible to design a braced tower of the usual type that would be proof against resonance. Perhaps a very flexible tower, with long, natural period, would be safe; at least the fact seems to be that most long-period structures come through earthquakes unscathed. But unless a period of quite a few seconds can be attained, as by rigid-frame type of construction, the remedy must be sought in damping.

The function of what is rather vaguely called dynamic design would thus appear to be to compute the period, and, unless this period is so far from any probable earthquake period as to make the problem really a static one, to provide next a damping of efficient and dependable kind. This last task will call for considerable skill and care on the designer's part, but it shoud be readily possible. The total energy to be absorbed is in no case large (relatively few horsepower, or no more than a good automobile brake absorbs in regular service), and ordinary ingenious mechanical design will have no trouble in meeting the requirement. This done, the structural design need not go beyond static-load provisions.

CURRENT NEWS

Merrimack Valley Sewer District Reestablished in Massachusetts

In the closing days of the Massachusetts legislative session, the Merrimack Valley Sewerage District bill (*ENR*, Aug. 1, 1935, p. 167), which lapsed last December because of non-fulfillment of the provisions (*ENR*, Dec. 19, 1935, p. 866), became law. If the federal government appropriates $10,000,000 before 1938, a comprehensive system of trunk sewers, pumping plants, and other works may be constructed by a board set up under the act. The act permits the Governor to name an unpaid board of five men who may name a chief engineer who is to be the executive manager of the district, and may appoint a staff and clerical aids as required up to a maximum salary list of $10,000 per year. Under the revised law, the board is authorized to act jointly with the New Hampshire Water Resources Board as the Merrimack River Valley Authority; the Authority will act as a "planning board relative to all work and projects deemed by it as reasonably necessary and proper for the preservation and maintenance of the health, welfare and safety of the inhabitants of the watershed of the Merrimack River and its tributaries in New Hampshire and Massachusetts," with power to recommend legislation.

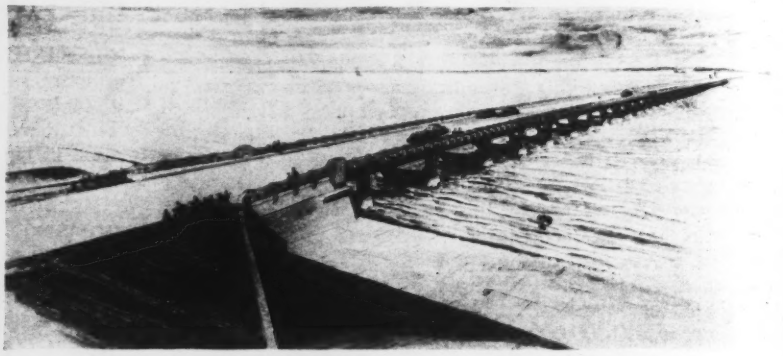
The Massachusetts board may construct sewerage works in the valley subject to the approval of the state board of health, and may operate such works for revenue, deficits being assessed in proportion to the population of the 16 municipalities included in the act. All construction costs, except land damages, are to be paid for from the hoped-for federal appropriation. Local sewerage systems are to be coordinated in operation with the district system.

Montreal Must Build Sewer Or Pay Fine

The city of Montreal has been officially warned by the director of the Provincial Bureau of Health that it must take steps to construct the long-planned Trenholme Ave. trunk sewer, or else expose itself to damages for the nuisance created in the village of Cote St. Luc which the sewer is designed to remedy. The city is therefore calling for new bids for the construction of the sewer, since the lowest of those already submitted has been withdrawn.

The bureau's order arose out of the action of the village of Cote St. Luc, adjoining the city of Montreal, which town will be served by the new sewer, in threatening to invoke the Quebec public health act and the municipal code of the province of Quebec to compel the city of Montreal to pay fines of nearly $50,000.

This sewer is a part of the major program of sewer construction started some years ago by the city of Montreal on instructions of the Bureau of Health. Bids were called for in December, 1935, and opened on Jan. 9; no contract was awarded.



NEW GALVESTON CAUSEWAY TO RELIEVE TRAFFIC CONGESTION

Construction has been started by the Texas State Highway Commission on a new causeway across the West Bay at Galveston. Highway access to Galveston at the present time is restricted to a single two-lane roadway, which carries one of the heaviest traffic intensities in Texas. The new structure, parallel to and about 500 ft. southwest from the present causeway, will relieve the congestion. The new bridge is 13,200 ft. long, 9,600 ft. from shore to shore, and includes 8,194 ft. of bridge. A double leaf draw-span will provide a clear opening of 105 ft. at the Intracoastal Canal. The roadway will be 40 ft. wide between curbs, with two narrow sidewalks. The bridge was designed for the State Highway Commission by Terrell Bartlett; the contractors are the Austin Bridge Co. of Dallas.

Permanent Board For Resources Study

Committee asks that it be made a permanent organization, and recommends establishment of a land-use subcommittee

A PROGRESS report made to President Roosevelt by the National Resources Committee again recommends that the committee be set up by law as a permanent board. The report recommends that the board should not be placed in any of the regular departments of the government, but be directly attached to the President's executive staff. The committee fears that, unless this is done, the National Resources Committee will become a purely advisory board without usefulness.

The committee recommends that a National Development Administration be established to negotiate agreements between federal departments and local governments for the performance of public works and to allocate costs in accordance with policies prescribed by Congress. Creation of a permanent land section under the National Resources Committee, made up of representatives of the various agencies concerned, to coordinate government policies with respect to land use is also urged. The committee recommends further large-scale purchases of land by the federal government for the protection of areas that cannot be made commercially profitable, further encouragement of zoning by states and counties, continuation of the soil conservation program, and a re-study of reclamation problems by the departments of the Interior and Agriculture.

The committee reports that the limited time and funds available will restrict the study of water use and control in major drainage basins, on which the committee on water resources is now engaged, to the production of a skeleton plan of a preliminary character. This plan will be submitted to the President Dec. 1.

As regards the status of its present work, the committee reports that Prof. Simeon Leland's study of costs of and responsibility for public works will be ready for publication about Dec. 1; that a six-year program of federal projects is being prepared in cooperation with the Public Works Administration; and that state planning boards have been requested to prepare similar schedules of state projects.

The water resources committee has a number of projects under way, in cooperation with the interested local bodies. They include: an investigation of the upper Rio Grande basin; a study of the Red River of the North; flood studies at Kansas City; and an investigation of the relations between federal, state, and other political subdivisions for enforcement of river pollution control.

Contractor on Oakland Tunnel Sues Highway District

Six Companies of California, contractors on the Broadway highway tunnel at Oakland, Calif., have filed a $3,295,695 breach of contract suit against Joint Highway District No. 13, owners of the tunnel.

The suit follows the action of the contractor in stopping work under the contract on June 13 (*ENR*, June 25, 1936, p. 933). At that time the contractor claimed that ground conditions were not as represented in the information furnished to bidders. Since May 24, the scheduled completion date for the tunnel, liquidated damages of $500 per day had been charged against the contractor.

Water Supplies in the Drought Areas Found Not To Be Seriously Affected

District Engineers of the U. S. Geological Survey report on water supply conditions throughout the drought area—Few supplies have failed and others are adequate unless drought is of long duration—Most deficiencies are in towns having surface supplies

COOLER temperatures followed by some precipitation brought relief over a considerable portion of the drought area this week. It was too early to predict, July 14, whether the drought had been definitely broken. As in other years, its border is constantly changing, and diverse conditions prevail even in the dryest areas. The record of precipitation shows, however, that since May 1 rainfall has been below normal over a large part of the country. This has not seriously affected public water supplies, and, except in Minnesota, conditions are not nearly so critical in this respect as in 1934. Conditions prevailing on July 9 show that no widespread water-famine is likely unless the precipitation that occurred rather generally this week fails to continue.

Tennessee and Kentucky

Water supplies in some areas of Tennessee and the Cumberland basin of Kentucky were curtailed. Decatur, in Meigs County, experienced a decided shortage. There was no serious shortage for industrial purposes. Springs and wells as a whole held up better than in the drought periods of 1931, 1932 and 1934. The drought in this district was not as long as in those years, and ground water was well above average to start with. Some springs that went dry in 1930 or 1931 continued to flow this year. Rivers in the Cumberland area were lower for this time of year than in 1931 and 1932. Water was released from Norris Reservoir during the latter part of June to aid navigation in the Tennessee River. Tennessee tributaries reached very low stages for this time of year but did not go as low as during the fall of 1931, 1932 or 1934. From the middle of April to June 30 rainfall was deficient. Up to the middle of April there was an excess which helped to maintain the ground water supply above normal and probably tided over spring and well-water supplies. April rainfall was 0.11 in. more than the average, May was 2.79 in. less than average, and there was very little rainfall in June. Heavy rains over the whole area, July 1-4, terminated drought conditions, however, and produced minor floods in central Tennessee. On July 9 this area as a whole was in good condition with respect to ground moisture and stream flow.

Ohio

There have been no reports of shortage of municipal or industrial water supplies, but inadequate pumping facilities to meet the peak demand are reported in some places. The average deficiency in rainfall for the state as a whole, to June 30, was 2.03 in. below normal. This compares with a deficiency of 7.65 in. in the same period of 1934. The deficiency, to July 8, at Columbus was 4.96 in. as compared with a deficiency of 10.03 in. in the same period of 1934.

Indiana and Northern Kentucky

No serious shortage in water supplies for any use is known to have occurred. Some restrictions on the use of water have recently been applied in a few towns. Stream flow in northern Indiana is about the same, or slightly higher, than at this time in 1934; streams in southern Indiana and Kentucky are slightly lower. No serious deficiency in rainfall occurred prior to June. Since the first week in June, only a few scattered showers have fallen.

Illinois

The drought has not been sufficiently prolonged to deplete any important water supplies, so municipal and industrial consumption has not been affected. The drought has persisted over most of the state since April. Precipitation was 62 per cent of normal in April and 53 per cent of normal in May.

Missouri and the Dakotas

Drought in Missouri is not yet as critical as it was in 1930, 1931 or 1934, probably because rainfall during 1935 was above normal. Rivers and springs are very low for this season of the year but have not yet reached the low flows recorded in 1930 and 1934 except in a few localities. The drought is more severe in the southern than in the northern part of the state. In northern Missouri most towns receive public water supplies from surface streams. Several are curtailing use, but none has had to ship water in from other places as was necessary in 1930, 1931 and 1934. Unless more precipitation occurs, however, streams are likely to go completely dry during the latter part of July and August. In the southern part of Missouri most towns obtain public water supplies from deep wells. Only a few suffered shortage during 1930, 1931 and 1934, and there has been practically no shortage this year. The average rainfall for the state, April 1-July 7, was 7.07 inches, which is 49 per cent of normal, and June received only 41 per cent. Distribution was irregular. Some wells and springs in central and southwestern sections of the state are exhausted or are lower than ever before known. Some which withstood the 1934 drought have failed.

Streams in the Dakotas are very low and many have gone dry, but most of the towns get their public supplies from deep wells, which have proved to be adequate. The James River in eastern North Dakota and South Dakota, which furnishes most of the towns in that region with their public supplies, is very low, and water shortages are being experienced.

Kansas

Water supplies for municipal and industrial purposes have not yet failed. Creeks draining small areas are dry, but larger rivers are not as low as in 1934, and water supply conditions are not as severe. Little shortage of domestic and city water supplies has been noticed. This is partly due, in the district engineer's opinion, to improvements in water systems made during the past two years. Rainfall was very scarce in the lower Kansas basin and Osage basin in Kansas in June. It was inadequate in all parts of the state, except a few favored spots. There were more clear days than in any other June in 50 years, and the average temperature has been exceeded only nine times in the same period. Only in 1911 and 1933 has there been less rain. About half the state failed to receive as much as one inch.

Iowa

There have been no reports of failure of municipal or industrial supplies. Surface water and shallow well supplies are holding up excellently. Farm and village supplies, with a few exceptions, appear to be adequate so far. Stream flow throughout the state is well above 1930 and 1934. Typical, probably, is the present flow of the Iowa River. The gage at Wapello, on July 9, was about 0.8 ft. higher than the minimum in 1934. Conditions are so much more favorable than in the corresponding period of 1934 that comparison is scarcely possible. Water supplies in particular are in very much better condition. At the end of June the accumulated deficiency in precipitation since Jan. 1 was 6 in., and rainfall has been lacking in many parts of the state for more than a month. Over a belt extending from Mills, Pottawattamie and Harrison Counties in southwestern Iowa to Floyd County in north central Iowa there has been less than 0.25 in. of rain during the past 31 days.

Minnesota and North Dakota

Municipal water supplies in the Red River valley are in critical condition. The flow in all streams decreased very rapidly during June, and, due to clear weather and hot winds, evaporation has been heavy. In Fargo, which depends on the Red River supply, the river ceased to flow over the dam June 14 (in 1934 the flow ceased May 21), and since then the pool has been reduced nearly three feet. The cities of Thief River Falls, Red Lake Falls, Crookston, East Grand Forks, and Grand Forks obtain their supply from Red Lake River. There was no flow in the upper Red Lake River out of Red Lake in early June, as all water was being stored. On June 20, Thief River Falls induced the Indian agent to permit some flow. This reached Thief River Falls July 5, but, on July 9, had only been able to maintain the level of the storage pool; no water is being permitted to go down the river from that point. Cities downstream depend on the flow from Clearwater Lake, which, on July 4, was about 26 sec.-ft. Hot weather and the low flow have been conducive to the growth of aquatic plants, so transportation of water is slow, and there is marked loss by evaporation and transpiration. On Ottertail River there has been a mean daily flow past Dayton Hollow Dam, near Fergus Falls, of 15 sec.-ft. This flow takes water as far as Breckenridge, but only a slight amount passes over the storage dam at that point, and none reaches the pool at Fargo.

Throughout the entire district, water supplies for hydro-electric power are becoming very short. The most critical shortage is occurring in Red River valley, where the plant on Red Lake River at Crookston had to cease operation July 13 (in 1934 operation ceased July 7), and the power plant on Ottertail River at Dayton Hollow is only operating one hour in each 24. No shortage of water in farm wells has been reported, but pasture water holes are drying up. Stream flow and lake water levels in the Red River Valley indicate that present conditions are about as serious as in 1934. Throughout the district comprising Minnesota and eastern North Dakota there was a fair amount of snowfall last winter.

and, following a late break-up, nearly all streams reached higher stages than at any time during the past five or six years. Until the end of April, precipitation was nearly up to normal, but since then the deficiency has increased greatly in western Minnesota and North Dakota. The only saving features have been the amount of moisture in the ground early in the season and the cool temperatures that prevailed until shortly after July 1, when there was a sudden rise ranging, July 4-8, from 100 to 116 deg. in North Dakota and nearly as high in western Minnesota, accompanied by hot south winds.

Relief for drought areas

The drought has been officially mapped as including 336 counties in twelve states, and early this week it appeared likely that the quota of 75,000 farmers and others to be transferred to WPA employment rolls by reason of the drought will probably be exceeded. They will be put to work on road building, soil and water conservation, forestation, and sanitation projects. Direct relief is being handled by WPA.

Contract Let for Lock At Mouth of Chicago River

Contract for the construction of a lock and guide walls at the mouth of the Chicago River in Chicago was let on July 9 by the Sanitary District of Chicago to the Frazier-Davis Const. Co., of St. Louis, for $1,988,785. The lock, equipped with control works, will reduce the diversion of Lake Michigan waters through the Chicago River to 1,500 sec.ft., the limit set by a U. S. Supreme Court order effective Dec. 31, 1938. The lock chamber will be 600 ft. long, flanked by 2,839 ft. of guide walls. Top of lock and walls will be 7 ft. above river level. Water depth at the site, 1,800 ft. east of the new Outer Drive bridge, is 33 ft. Further contracts, which are estimated at $605,000, will be let during the coming year. These include electrical work, waterproofing and additional walls.

On the same date the Sanitary District awarded a contract to the E. L. Albrecht Co. for the construction of the outfall works at the Southwest Side sewage disposal plant, on a bid of $287,522. Construction of the plant, the largest in the world, is well along, as is the work on the intercepting sewers that will serve the plant.

C.N.R. Gets Federal Permission To Build Quebec Branch Line

The federally-owned Canadian National Ry. has obtained permission from the federal Parliament to construct a branch line in northern Quebec from Senneterre, on the C.N.R. transcontinental line, to Rouyn, on a C.N.R. branch line. The act authorizes construction of 99 miles of track at $60,000 a mile.

The proposed line is a part of the line which the Canadian Pacific Ry. has sought permission from the Quebec legislature to build (*E.N.R.* June 18, 1936, p. 897). The C.P.R. proposal obtained a favorable report from the committee on railway development and got as far as its first reading in the Quebec legislature; further action, however, was pevented by the resignation of Premier Taschereau.

Prequalification Started in N. Y. State

The system is not mandatory and is to be applied only to certain highway contracts on Long Island

A MEASURE, passed by the legislature of New York State and approved by the Governor, provides, for the first time in this state, for prequalification of bidders on highway contracts. The new law, which is not mandatory, permits the highway department to demand of bidders that they qualify before their bids are considered. Another feature of New York's new prequalification system is the inclusion of a bonus and penalty clause in the contract. A bonus of $100 per day will be paid the contractor for each day the work is completed in advance of schedule. Liquidated damages of $100 per day will be charged for time taken beyond the schedule. A form of prequalification statement has been prepared under the direction of the superintendent of public works, and will be furnished to prospective bidders with the proposal blanks. Information required includes a financial statement, a statement of previous experience of the firm and of principal officers, a list of work being done by the contractor at the time of bidding, and the schedule according to which the contractor proposes to do the work.

For the present, the prequalification system will be applied only to certain contracts shortly to be let in the Long Island area. The system is being applied here because, in order to be ready for the 1939 World's Fair, prompt execution of contracts is essential. Work on which the system will be applied includes: construction and paving of the west service road of the Grand Central Parkway extension, estimated to cost about $203,000, on which bids will be received on July 29; paving of service roads, approaches, and streets, adjacent to the Grand Central Parkway extension; underpasses at Northern Boulevard, Roosevelt Avenue, and 69th St.; construction of Horace Harding Boulevard, and of a bridge over Flushing Meadows Creek.

Long Section of Welded Rail Laid by Northern Pacific

One of the longest stretches of rail ever to be welded in one piece on a railroad system has just been laid in the 4,000-ft. Bozeman tunnel of the Northern Pacific Railway in the Montana Rockies.

Each 4,000-ft. length of rail was prepared by welding together a number of standard length 39-ft. steel rails, weighing 131 lb. per yard. The rails were laid end to end on 90 gondola cars, equipped with rollers, and the ends were welded with thermit metal. The cars were then moved into the tunnel, and the train was uncoupled in the middle. One-half of the cars were pulled away, permitting the rails to be lowered to the track. After one-half of the rail length had been unloaded, the remaining half of the train was pulled away, leaving the entire length of track resting on the ties.

Each 4,000-ft. length of rail weighed about 85 tons. The unloading was carried out in two hours and 35 minutes, without any delays to traffic.

Similar 4,000-ft. strings of rail will be used in the Blossburg tunnel west of Helena, Mont.

The use of welded rails in the tunnel eliminates frequent rail joint and track repair heretofore necessitated by the corrosive action of locomotive gases and moisture on rail joints in tunnels.

The Boston & Maine R. R. has a stretch of 17,600-ft. of rail welded into one piece in the Hoosac Tunnel, and the D. & H. R. R. has one stretch over two miles long.

At the last meeting of the A.R.E.A. the rail committee reported that it should be possible to weld lengths of rail up to 12,000 ft. on open track.

Rentals Announced on PWA Housing Project

Techwood Homes, the PWA slum clearance project at Atlanta, Ga., is the first federal housing project to be completed. Rentals on this project, including an allowance for heat, water and electricity, will average $7.39 per room per month. Stoves and refrigerators are provided as part of the project. The average monthly rentals, including the allowance for heat, water and power, are as follows for different size units:

Three room apartments	$23.47
Four room apartments	28.00
Five room apartments	32.08
Five room houses	34.83
Six room houses	38.19

The overall average rental per family per month will be $27.77. At present, in Atlanta, low-income families in the city pay an average of $27.75 for sub-standard housing.

These rental rates apply only to the Techwood project, Administrator Ickes points out. Rents will not be standard throughout the 50 projects of the Housing Division, but will be determined by the individual cost of each project. Administrator Ickes stated that he considered the rent on the Techwood project too high, and intimated that further federal subsidies might be necessary to lower the cost.

Contract for construction of the superstructure of the LaSalle Place low-cost housing project in Louisville, Ky., has been awarded to T. L. James & Co., of Ruston, La., on a bid of $1,048,200.

The George A. Fuller Co., of Chicago, has received the contract to construct the superstructure of Trumbull Park Homes, the housing project on Chicago's south side. The Fuller Company's bid was $2,533,300.

Blaine F. Smith Named Head Of Universal Atlas Cement Co.

Blaine F. Smith, who has just resigned as president of the Pennsylvania-Dixie Cement Corp., of New York, will become president of the Universal Atlas Cement Co. on Sept. 1. Mr. Smith succeeds B. F. Affleck, president of the Atlas Cement Co. and the Universal Atlas Cement Co. since 1917. Mr. Smith was previously associated with the Universal Atlas Cement Co. until 1928, when he resigned to become president of the Pennsylvania-Dixie Cement Corp.

John A. Miller, formerly chairman of the board of the Pennsylvania-Dixie Cement Corp., has been elected president of that company, replacing Mr. Smith.

McLaughlin Aerial Surveys

THE TRIBOROUGH BRIDGE at New York City was opened on July 11

$60,300,000 Bridge Project at New York Completed and Put into Service

THE TRIBOROUGH BRIDGE, connecting the New York City boroughs of Manhattan, Bronx, and Queens, was opened to traffic on July 11. The bridge, built at a cost of $60,300,000, crosses the Hell Gate channel from Astoria to Ward's Island, crosses Ward's Island and Randall's Island on a high viaduct, and connects with the Bronx by a fixed span over the Bronx Kills. Manhattan traffic leaves the viaduct at a circle giving complete separation of opposing traffic and continues on a viaduct to a lift span over the Harlem River, and thence to viaducts connecting with the new East River Drive and the streets of Manhattan. Also shown in the photograph are the new bathing pool in Astoria Park, between the new bridge and the Hell Gate arch, the new Ward's Island sewage disposal plant, and the new stadium on Randall's Island, where the Olympic tryouts began on the day the bridge was opened.

Engineers and Contractors

Engineers for the Triborough Bridge Authority include: O. H. Ammann, chief engineer; E. W. Stearns, assistant chief engineer; Allston Dana, engineer of design; H. W. Hudson, engineer of construction; J. C. Evans, engineer of approaches; E. Warren Bowden, assistant to the chief engineer; George L. Lucas, engineer of inspection; R. E. Robinson, deputy engineer of construction; Arthur I. Perry, principal assistant engineer. The field engineer's staff included J. E. Tonnelier, Homer R. Seely, H. C. Curtin, and R. T. Wheadon. The consulting engineering firm of Ash, Howard, Needles, and Tammen designed the Harlem River lift span.

Among the 60 contractors, the following list includes those whose contracts were for more than $400,000: American Bridge Co.; Arundel Corp.; Brown Electric Co.; Cauldwell-Wingate Co.; Corbetta Construction Co.; P. T. Cox Contracting Co.; A. M. Hazell, Inc.; Del Balso Construction Co.; Johnson, Drake & Piper; J. Leopold Co.; McClintick-Marshall Corp.; William P. McDonald Construction Co.; Porier & McLane Corp.; Frederick Snare Corp.; Taylor-Fichter Steel Construction Co.; Tulli & DiNapoli Co.; Albert A. Volk Co., and Woodcrest Construction Company.

Cost of the Project

Expenditures by the city before the Triborough Bridge Authority was set up:

Construction	$3,300,000	
Real estate	2,100,000	
Expenditures by the city since the Triborough Bridge Authority was set up:		
Real estate for approaches	$10,700,000	
Total city expenditures		$16,100,000
Expenditures by the Triborough Bridge Authority:		
For the bridge itself,		
Construction	$20,100,000	
Real estate	6,300,000	
		26,400,000
For bridge approaches,		
Construction	$13,200,000	
Real estate	4,600,000	
		17,800,000
Total expenditures of Triborough Bridge Authority		44,200,000
Total cost of bridge and approaches		$60,300,000

Large Construction Program For Argentine Approved

A comprehensive program of road construction in Argentina, prepared by the national highway department, has just been approved by the President of the Republic.

The project calls for a total expenditure of $90,000,000, to be spent over a period of five years. The plan, as approved, includes work which has been completed since 1934. About one-half of the total appropriation has already been obligated by past and present highway construction. The remainder is to be spent during the balance of this year and in 1937 and 1938.

It is anticipated that the highway department's program will be completed by the end of 1938 and that proceeds from the gasoline tax will more than cover the amount required.

Clarification Sought Of Tri-county Decision

The Tri-county Power and Irrigation District of Nebraska has asked the U. S. Supreme Court for a clarification of its decision that water from the Platte River may not be used outside the watershed of that river. The district is seeking to determine whether canals carrying water from the Platte River may run outside the watershed and then return the water to the watershed. About 15 miles of canal, already constructed, weave back and forth across the divide in order to obtain better ground conditions. It is estimated that, due to the necessity for levees and concrete lining of ditches in the unfavorable ground, it would cost nearly $300,000 to reroute the ditches entirely within the Platte watershed.

Washington Highlights

By Paul Wooton

The Bureau of Standards has asked President Roosevelt for an allotment of $500,000 to start a five-year program of research in building materials and methods. The Bureau is now engaged in a study of the permanency of building materials usable in low cost housing.

President Roosevelt states that he has no plans for further construction on either the Florida Canal or the Passamaquoddy tidal power project, since Congress has failed to provide funds. Consideration is being given, however, to use of the existing plant on both projects. In Florida, negotiations are under way with the University of Florida leading to a short-term lease of the buildings for use in giving extension courses. What use will be made of the Quoddy buildings has not yet been determined.

There has been no intimation by the President that he will curtail the $300,000,000 made available by Congress for grants to new projects out of the revolving fund derived by PWA from the sale of securities purchased in financing previous projects. The Reconstruction Finance Corporation confirmed on July 9 a committment to buy from PWA $103,099,000 face value of municipal bonds. This committment is part of the $250,000,000, which the RFC may invest at any one time in PWA securities.

The Public Works Administration has submitted to President Roosevelt projects covered by 45 per cent grants totalling $85,000,000. Approval of the projects will begin this week. The occasion for the delay is revealed by the President's announcement, July 10, that it is his purpose to use the new public works program to take people off WPA and direct relief rolls. The more people that municipal authorities can show as employed by the federal grant to its project the better chance it will have of getting the project approved, he explained.

The number on relief has been cut, but the total, said the President, is still greater than can be taken care of with the appropriation of $1,425,000,000 for WPA's relief work program. In conformity with the President's policy, PWA now is checking with municipalities which have applied for project grants to determine how many men will be removed from relief rolls by each project. This prerequisite to approval of a PWA application is similar in purpose to the procedure established a year ago when approval by WPA of PWA projects was required.

Land Purchased For Bayonne Terminal

The city of Bayonne has purchased from the state of New Jersey 200 acres of land and has obtained a fifteen-year option on 350 acres more of under water land, for its five million dollar ship-rail terminal on New York harbor. The terms of the sale provided for the purchase by the city of 200 acres at $3,000 an acre. Bayonne will pay $247,500 to the state at once, $100,000 on July 1, 1943, and $252,500 on July 1, 1951. The option will cost $5,000 a year additional.

SOCIETY CALENDAR

ILLUMINATING ENGINEERING SOCIETY, annual convention, Buffalo, N. Y., Aug. 31 to Sept. 3.

CANADIAN GOOD ROADS ASSOCIATION, annual meeting, Charlottetown, P.E.I., September 1-3.

PUBLIC WORKS CONGRESS, joint meeting, AMERICAN SOCIETY OF MUNICIPAL ENGINEERS AND INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, Toronto, Ont., September 28-30.

CANADIAN INSTITUTE OF SEWAGE AND SANITATION, Royal York Hotel, Toronto, Oct. 1-2, 1936.

AMERICAN WATER WORKS ASSOCIATION, CENTRAL STATES SECTION, Cleveland, Ohio, Aug. 19-21.

AMERICAN WATER WORKS ASSOCIATION, ROCKY MOUNTAIN SECTION, Denver, Colo., Sept. 21-23.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, New York, N. Y., Sept. 22-25.

AMERICAN WATER WORKS ASSOCIATION, NEW YORK SECTION, fall meeting, Saratoga Springs, N. Y., Oct. 22-23, 1936.

AMERICAN SOCIETY OF SAFETY ENGINEERS, NIAGARA FRONTIER CHAPTER, at a meeting in Buffalo, N. Y., on July 9 elected the following officers: Chairman, Philip Williams, safety engineer for Dupont Rayon & Cellophane Co.; vice-president, Clayton W. MacRitchie, safety supervisor for the E. I. duPont de Nemours Co.

EXAMINATIONS for registration as Engineers, Land Surveyors and Architects will be held as follows:

NEW MEXICO, examination for professional engineers and land surveyors, Santa Fe, Sept. 12.

Personals

M. E. LEEDS, president of the Leeds & Northrup Co., has been awarded the degree of doctor of engineering by the Polytechnic Institute of Brooklyn.

WILLIAM H. SLOAN, chief engineer of the New Jersey state highways department, has submitted his resignation, effective Nov. 1, and has received leave of absence until then.

COMMANDER WILLIAM M. ANGAS, Civil Engineer Corps, United States Navy, has been transferred from duty at the Navy Yard, New York, N. Y., to duty at the Navy Yard, Boston, Mass.

JOHN C. TRACY, professor of civil engineering at Yale University, who has been a member of the faculty there for the past 45 years, retired on July 1 and has been appointed professor emeritus of civil engineering.

FRANKLIN D. HOWELL, civil engineer of Los Angeles, Cal., has been appointed to the Los Angeles board of water and power commissioners. Mr. Howell is a past president of the Los Angeles chapter of the American Society of Civil Engineers. He was chief engineer of the city's board of public utilities from 1915 to 1918.

JOHN EDWARDS, JR., division engineer of the Monongah division of the Baltimore & Ohio R.R. at Grafton, W. Va., has been appointed assistant superintendent of the Baltimore division at Baltimore. H. L. EXLEY, on the staff of the engineer of maintenance of way at Baltimore, will be made division engineer at Grafton, succeeding Mr. Edwards.

F. A. TREVARTHEN has resigned [illegible] ing district engineer of the Huntington, W. Va., district of WPA. He is succeeded [illegible] Huntington by H. F. DILCHER, former assistant district engineer.

CHARLES M. HERD has been appointed [illegible] fice engineer of the Pasadena, Cal., [illegible] department. He formerly was engaged [illegible] school construction work for the Pasadena Board of Education.

LT.-COMMDR. CUSHING PHILLIPS, C.E., U.S.N., has been detached from duty [illegible] Navy Yard, Boston, Mass., and assigned [illegible] duty at the Naval station at Guantanamo Bay, Cuba.

A. B. GULICK, engineer with the American Locomotive Co., has returned to the home office of the company in Schenectady. For the past year he has been in charge of construction of a low-head water power station for the Orange County Water Co. of Orange, Texas, an irrigation project.

C. P. COLLINS, who for many years has conducted a consulting engineering office at Clarksburg, W. Va., has been appointed PWA resident engineer on a water and sewer project at Mason, W. Va. His office in Clarksburg is closed for the duration of this project.

Obituary

H. W. VANDERWERF, 44, vice-president of the Vanderwerf Co., general contractors, died on July 3 in San Fernando, Cal.

JOHN DEFREIS, 65, a contractor in Buffalo, N. Y., since 1896, died in that city on July 6.

FRANK RIDLEHOOVER, 34, resident highway engineer of the Kentucky state highway department, died in Mayfield, Ky., on July 3.

GEORGE C. SHAAD, dean of engineering and architecture at the University of Kansas, died in Pasadena, Cal., on July 9 at the age of 58.

RAOUL LACROIX, chairman of the board of examiners for the Quebec Association of Architects and president of the Royal Architectural Institute, died on July 5 at the age of 62.

JAMES A. SILVER, a contractor in Milwaukee for the past 30 years, former president of the Sterling Engineering & Construction Co. and the National Engineering & Construction Co., died in Milwaukee on July 3 at the age of 76.

HENRY WRIGHT, 58, architect, planning expert, and professor of town planning at Columbia University, died in New York City on July 10. Mr. Wright was a graduate in architecture of the University of Pennsylvania. He has acted as chairman of the City Planning Association of St. Louis, Mo., director of the American City Planning Institute, and chairman of the committee on community planning of the American Institute of Architects. In association with Clarence Stein, he planned the Sunnyside housing development in Queens, N. Y. C., the Radburn, N. J. development, Chatham Village at Pittsburgh, Pa., and, recently, the Green Brook, N. J.

project of the Federal Resettlement Administration. In 1933-34 he acted as consultant for the housing division of the Public Works Administration.

JOHN S. GALVIN, chairman of the Port of New York Authority prior to his resignation in November, 1933, and since then Director of Port Development, died in New York on July 12. He was 77 years old. Mr. Galvin had served on the Port of New York Authority since 1923. Before being appointed to the board of the Port Authority, he served as president of the Board of Water Supply of New York City, acting in that capacity during the construction of the Catskill system.

PHILIP P. SCHEERER, 53, a civil engineer for Groassman & Kreh of Elizabeth, N. J., and formerly first assistant engineer with the Long Island R. R., died at Elizabeth on July 11.

JACOB P. MILLER, a building contractor in Canton, Ohio, for more than 60 years, died there July 8 at the age of 93.

HENRY R. AFFERSON, 68, died in New York City on July 9. Mr. Afferson had in the past served as chief engineer for the Brooklyn park and sewer departments. He later served as an examiner of the New York civil service commission and as a consulting engineer in New York City.

FRANK S. HART, retired water superintendent of Framingham, Mass., died in that city on July 11 at the age of 84. He was an engineer for the Boston water supply department from 1891 until his retirement in 1922. Before that time he had been engineer of locks and canals at Lowell, Mass.

HENRY BROWER WALLIS, a retired building contractor of Beverly, Mass., died in that city on July 10 at the age of 93.

CONSTRUCTION STATISTICS FOR THE WEEK

ENGINEERING construction awards total $42,689,000 for the week compared with $60,847,000 last week and $23,607,000 last year. This week's total is made up of private, $11,631,000, and public, $31,058,000, of which federal is $8,505,000 and state and municipal, $22,553,000. Corresponding values a year ago were: private, $7,239,000; public, $16,368,000; federal, $5,816,000; state and municipal, $10,552,000.

Bridge awards for the week are high, $3,135,000 for privately owned bridges and $6,186,000 for public bridges. Other classes of work are lower than the high volume reported last week. The principal classes of construction for this week show following values: industrial buildings, $3,501,000; commercil buildings, $4,867,000; public buildings, $7,446,000; highways, $7,794,000; sewerage, $2,898,000; waterworks, $618,000; earthwork, drainage, $3,450,000; unclassified, $2,794,000.

The larger awards include: laboratory, General Motors Corp., Detroit, Mich., $1,000,000; factory for Inland Mfg. Co., Dayton, Ohio, $400,000; apartments for Colonial Homes, Cincinnati, Ohio, $3,000,000; senior high school, Sacramento, Calif., $646,000; superstructure, LaSalle Place Housing Project, Louisville, Ky., $1,048,000; superstructure, Trumbull Park Housing Project, Chicago, Ill., $2,533,000; highways, New York, $1,256,000; Mississippi, $1,474,000; superstructure and substructure for bridge across Rockaway Inlet from Marine Park, Brooklyn, to Jacob Riis Park, Queens, New York, $3,735,000; covering tracks for New York Central R.R., part of West Side Elevated Highway, New York, N. Y., $2,943,000; bridges, Indiana, $450,000; Oklahoma, $796,000; Washington, $551,000; Division "A," Chicago River Controlling Works, Sanitary District, Chicago, Ill., $1,989,000; earthwork in Mississippi River for U. S. Engineer, Vicksburg, Miss., Arkansas, $656,000; 20,400 tons ¾ to 1¼ in. steel reinforcing bars, U. S. Engineer, Los Angeles, Calif., $834,000; 2 airplane hangars, Public Utilities Commission, San Francisco, Calif., $736,000; welded steel pipe, Birmingham, Ala., $984,000.

New capital for the week includes state and municipal bond sales of $6,080,000; corporate security sales, $3,333,000; and $686,282,000 in federal funds, including an arbitrary credit of one-fourth the 1936-37 WPA construction funds, and the highway, Reclamation Bureau, Rivers and Harbors, and First Deficiency Act appropriations passed by Congress.

CONTRACTS
(Thousands of Dollars)

	Weekly Average July 1935	Prev. 4 Weeks	Week July 16 1936
Federal Government	$3,826	$10,326	$8,505
State and Municipal	12,285	26,883	22,553
Total public	$16,111	$37,209	$31,058
Total private	5,607	13,616	11,631
Week's total	$21,718	$50,825	$42,689
Cumulative to date: 1935	$718,220,000	1936	$1,262,378,000

NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

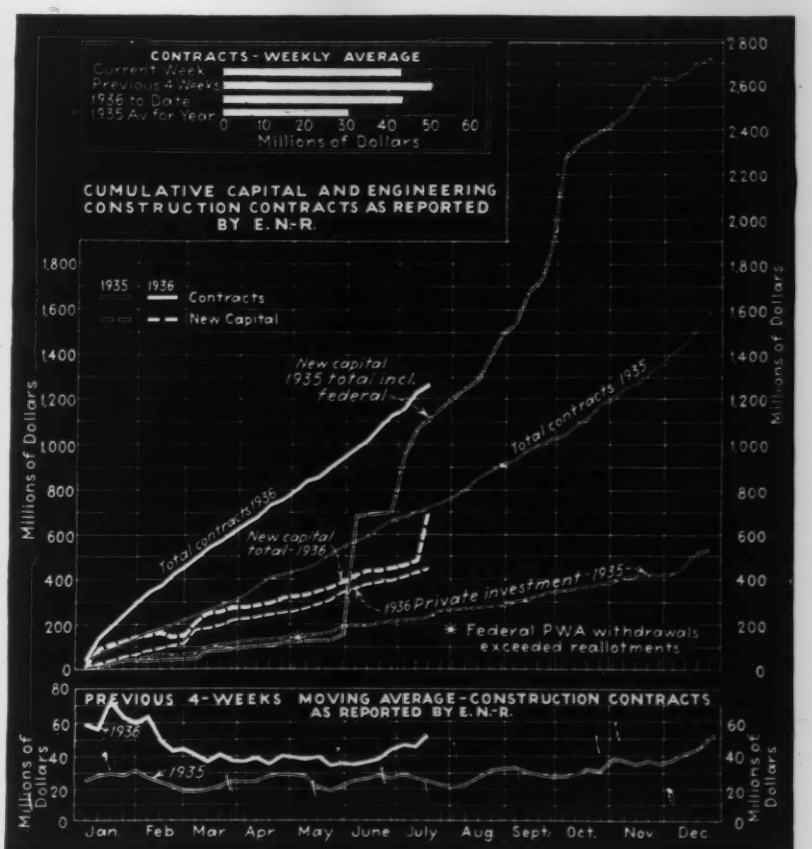
1936	Week July 16	Cumulative
State and municipal	$6,080	$299,367
PWA non-federal	....	32,190
RFC loans	....	12,479
Corporate issues	8,268*	141,992
PWA loans, Private	—4,935*	—1,665
Total Non-Federal	$9,413	$484,363
Federal	686,282	691,237
Total new capital	$695,695	$1,175,600
Cumulative to date: 1935	$1,062,888,000	1936 $695,695,000

*Transfer from federal to private through sale by RFC of PWA bonds.

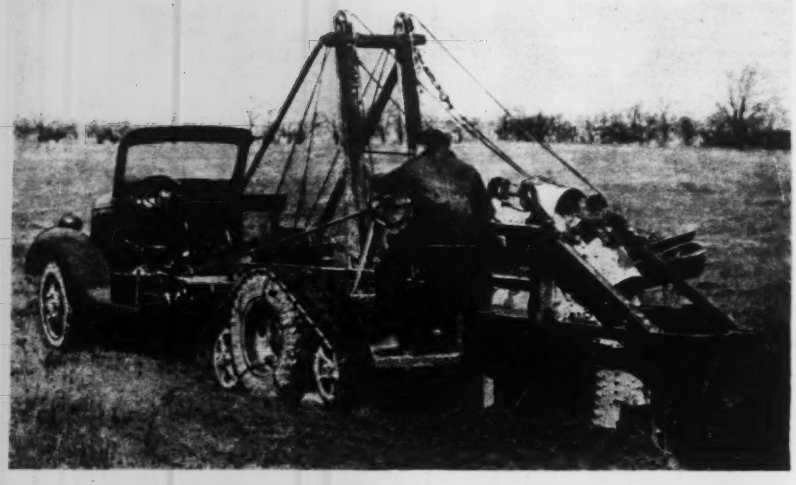
Note: These figures include private bonds, and stocks sold for productive purposes; state and municipal bonds for construction; PWA loans and grants to states and municipalities, including the special highway funds; PWA private loans, and allotments for federal construction, deficiency act funds.

INDEX NUMBER

ENR Cost	1913 = 100	1926 = 100	ENR Volume	1913 = 100	1926 = 100
July, 1936	202.60	97.38	June, 1936	196	86
June, 1936	204.60	98.35	May, 1936	149	65
July, 1935	195.18	93.82	June, 1935	122	54
1935 (Av.)	195.22	93.84	1935 (Av.)	135	58
1934 (Av.)	198.10	95.23	1934 (Av.)	114	50
933 (Av.)	170.18	81.80	1933 (Av.)	102	47


CONTRACTS - WEEKLY AVERAGE
Current Week
Previous 4 Weeks
1936 to Date
1935 Av. for Year
0 10 20 30 40 50 60
Millions of Dollars
CUMULATIVE CAPITAL AND ENGINEERING CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1935 1936
Contracts
New Capital
New capital 1935 total incl. federal
Total contracts 1935
Total contracts 1936
New capital total 1936
1936 Private investment 1935
* Federal PWA withdrawals exceeded reallotments
Millions of Dollars
PREVIOUS 4-WEEKS MOVING AVERAGE - CONSTRUCTION CONTRACTS AS REPORTED BY E.N.-R.
1936
1935
Jan. Feb Mar Apr May June July Aug. Sept. Oct. Nov. Dec

Construction Equipment and Materials



Truck-Mounted Ditcher

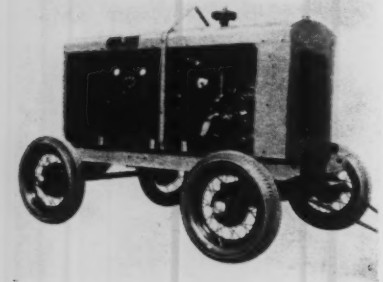
The Model 16 Utility Ditcher, built by the Buckeye Traction Ditcher Co., of Findlay, Ohio, is said to have a wide range of service in small trench digging. The ditcher, mounted on a standard truck chassis, can be moved rapidly from one location to another at regular road speed. The truck motor furnishes the power for the ditching mechanism through a special transmission. The motor is supplied with an oversized radiator for better cooling facilities.

Buckeye "Alligator" crawlers are applied to the dual rear wheels of the truck. Small detachable idler wheels in front of and behind the rear wheels increase the crawler area. These crawlers, it is claimed, can be put on or taken off in about 20 minutes.

The Model 16 has a maximum cutting depth of 4 ft. 6 in., and cutting widths from 9½ in. to 16½ in.

Portable Welding Unit

Portability is a feature of a new welder which has just been introduced by the American Tractor Equipment Company of Oakland, Calif. The welder is available either with or without a rigidly connected trailer undercarriage. There is a bale attached directly to the main frame so that it can be lifted into difficult locations by a crane; and the ends of the main frame members are bored for insertion of bars for hand lifting.



Source of power is a 4 cyl. Ford industrial motor, developing 23 hp. S.A.E. The generator is of Apeco-Roe design and construction, with a capacity of 300 amperes. It is claimed that this generator will operate continuously for an indefinite period without exceeding a temperature of 60 deg. C. The 25-gal. fuel tank holds enough gasoline for more than eight hours of continuous operation, obviating the necessity of shutting down in the middle of a shift to refill. Space is provided for storing welding equipment inside the unit.

On wheels, the welder weighs about 2200 lb.; on skids, 1850 lb. A tongue for towing is provided.

New Equipment in Brief

Compressor—A new compressor unit designed for truck mounting with direct drive from the propeller shaft of the truck is being built by the Sullivan Machinery Co. of Michigan City, Ind. The compressor is two-stage air-cooled with a capacity of 105 cu. ft. per min.

Indicator—A new device manufactured by the Electric Storage Battery Co. of Philadelphia, the Exide Discharge Indicator, is intended to warn operators of electric industrial trucks when the battery needs recharging. The device consists of a warning lamp and a relay, set to operate at a predetermined voltage. When the voltage drops to the critical value, the relay operates and the lamp lights.

Electric Marker—The Ideal Electric Marker, manufactured by the Ideal Commutator Dresser Co., of Sycamore, Ill., is a portable electric tool which, it is claimed, can be used for marking on practically any material, irrespective of whether it is a metal or a non-conductor of electricity. The unit is 6¾ in. long, and weighs 2 lb. It operates on 110 volt 60 cycle a.c. current and consumes about 75 watts.

Valve Motor—The Taylor Instrument Co. have redesigned their Motosteel diaphragm valve motor to use an all-steel welded construction. This new construction is claimed to be lighter in weight, stronger, and to have greater resistance to shock and strain than the cast iron type.

AIR COOLING OF THE BOYER riveting hammer, manufactured by the Chicago Pneumatic Tool Co., is claimed to result in reduced breakage of rivet sets, possibility of longer continuous operation, and increased efficiency of the hammer. The small arrows indicate the flow of exhaust air.

Manufacturer's Activities

Plant Expansion

● Iron and Steel Products, Inc., of Chicago, dealers in railway supplies and equipment, have purchased the North Works of the Ryan Car Company in Hegewisch, Illinois, a Chicago suburb. The purchase covers all the buildings and about 27 acres of land.

● Rapidly increasing business compels the R. G. Le Tourneau Co., to increase the capacity of their Peoria, Illinois, plant for the third time in a little more than a year. The new unit will more than double the capacity of the plant, increasing the output from three scrapers per day to seven scrapers per day, plus a number of other units.

Organization Changes

● The American Hoist and Derrick Company has appointed J. L. Craytor District Manager for the South and South Eastern Section of the Country, including the States of Alabama, North and South Carolina, Georgia, Florida, Tennessee, Kentucky and Mississippi.

● Everett Morss, Jr. has been elected president and treasurer of the Simplex Wire and Cable Co. of Boston, succeeding the late Henry A. Morss. Charles R. Boggs, vice-president, becomes general manager instead of Factory Manager, and Philip R. Morss, vice-president, has been elected Clerk and Secretary. Assistant Treasurer, J. Arthur Gibson, becomes vice-president.

● Recent changes in the sales force of the Link-Belt Co., of Chicago, include: addition of J. B. Bloomfield to the shovel, dragline, and crane sales division; appointment of L. P. Spillan as division sales manager for the same division, and appointment of N. A. Weston to handle shovel division industrial sales in the Chicago District.

● To handle the increased export business of the Waukesha Motor Company, M. E. Nicklin has been appointed export manager.

● William H. Phillips has joined the Worthington Pump and Machinery Corporation as Power Plant Specialist. He was formerly with the Harry Pratt Company.